ENGINEERING NEWS

AND

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ENGINEERING NEWS.

THE BROOKLYN BRIDGE TRUSTEES have passed a wise but curiously worded resolution, given in another column, which asserts in terms that "*Whereas*, Plans for improving terminal facilities, including the erection of new stations, have on the recommendation of three different committees been separately adopted by the trustees, *Resolved*" that a fourth committee be appointed to consider plans, etc.! If passing resolutions and appointing committees of miscellaneous business men would only solve the Brooklyn Bridge problem, it would have been satisfactorily solved long ago. As it is, the resolution is simply a formal confession of what was before tacitly confessed, that the "adopted" plans were unworkable, and could not be carried out, as we said long ago.

THE RESOLUTION goes on to say, however, that this committee is to consider "plans and means necessary to permit the *maximum possible* travel to be handled with *comfort, safety, rapidity*, and *economy*, with stations *suitable for the uses intended* and in harmony, architecturally, with the structure proper." Such instructions, if faithfully carried out by men competent to carry them out, could not well fail to produce useful results; but as the committee is to consist merely of President HOWELL, and four trustees appointed by him, and as the only man on the Board of Trustees who possesses any known qualifications for such duty is Mr. GEO. W. MCNULTY, the mover of the resolution, the prospect is less hopeful. On Mr. MCNULTY will rest a great responsibility, since he is the only engineer on the Board, and hence the only man with a professional reputation to be enhanced or obscured by the committee's actions.

A COURSE IN SANITARY ENGINEERING has been added to the ten other courses of the Massachusetts Institute of Technology, as noted elsewhere. The course curtails the attention given to railway and mechanical engineering, astronomy, metallurgy of iron and geology, and devotes the time thus saved to chemistry and biology, with a special course on heating and ventilation.

A PRESS DESPATCH states that Mr. J. C. PILLING, Acting Director of the Geological Survey, has made a report to the Secretary of the Interior of the progress made during the month of July last in the survey for the irrigation and the reclamation of the arid lands of the West. Under the topographic division the total area surveyed was 3,650 sq. miles, operations being continued in California, Idaho, Colorado, Montana, New Mexico, and Nevada. One field-party in California has commenced a thorough survey of Clear lake, with a view to determine its capabilities as a reservoir site and ascertain the best means of storing water and applying it to the lands below its outlet. Donner lake, near Truckee, in the Western Nevada section, is being surveyed. It is thought that by the construction of a dam two miles below the lake's outlet, a large body of water can be stored at a very moderate cost. The work in the Rio Grande section was confined to a careful survey of a very large reservoir site, which seems practicable by the construction of a dam in the Rio Grande river near El Paso. This project, the report says, is one of profound interest and perhaps will involve international questions. Care has been taken to avoid any action which would complicate such questions if they should arise.

ELECTRIC LIGHTING is to be introduced into the underground workings of the iron mines at Ironwood, Mich., by Capt. S. S. CURRY, President of the Metropolitan Iron & Land Co. It is expected that the new light will considerably enhance the safety of working, since with the better light the mine inspectors can keep a closer watch against impending falls of roof.

HEAVY ROLLING STOCK continues to increase. The Baltimore & Ohio Railroad has in service a very heavy Consolidation engine, known as class E-6. Its general dimensions are: Cylinders, 20 ins. diam., and 26 ins. stroke; driving wheels, 50 ins. diam.; fuel, bituminous coal; total wheel base, 23 ft. 2 ins.; driving wheel base, 15 ft. 4 ins.; total wheel base of engine and tender, 48 ft. 7¼ ins.; total weight in working order, 124,300 lbs.; on drivers, 112,900 lbs.; total weight of tender, with fuel and water, about 62,000 lbs. The boiler is 55 ins. outside diameter at smoke box end, of ½-in. steel in cylindrical part, ⅝-in. throat sheet; tubes, 198 in number, 2¼ in. outside diameter, 13 ft. 8 in. long; firebox, inside dimensions, 120 ins. long, 34½ ins. wide at bottom, 48⅝ ins. wide at crown sheet, 70½ ins. high in front, 51⅛ ins. high at back. The engine is equipped with the American steam driver brakes.

THE LEHIGH VALLEY RAILROAD has built an exceptionally strong flat-car for the carriage of heavy machinery, landed from England at Perth Amboy, to the Bethlehem Iron Company, at Bethlehem, Pa. This car is 35 ft. 8 ins. long to end of sills, 8 ft. wide to end of side rails, there are six longitudinal sills of Southern pine 4 1-2 × 12 ins.; four of them reinforced by channel bars of iron, and four body bolsters of channel bars 10 ins. wide, and ⅝-in. web. The body is trussed with six 2-in. rods upset to 2½ ins. at the ends. The car is carried on two six-wheeled equalized trucks, 33-in. steel tired wheels, with journals 5 ins. in diameter and 9 ins. long, and bearings of phospor-bronze. The car has carried a load of 122,734 lbs. without any perceptible sag in the body, and without any indications of heating. The weight of the body is 21,700 lbs., and of the trucks 23,800 lbs.; total 45,500 lbs. If cars of this sort are to be run over a road, it will be well not to pare down the sections of bridge members too closely!

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head collision Sept. 8 on the New York, Pennsylvania & Ohio, near Greenville, Pa. A freight train was standing on the side track, and a brakeman had been ordered back to open the rear switch. Being a new man he misunderstood the order and opened the head switch, turning the vestibule express onto the side track. The baggage car was telescoped and the baggage-master killed. This is but another of the accidents due to lack of proper signal and interlocking equipment.—Other accidents of a similar kind are reported: On Sept. 6, the rear car of a passenger train on the New York, Pennsylvania & Ohio, was derailed at Pymatung by a freight brakeman opening the switch before the car had cleared it; 5 persons were injured. On Sept. 6, the carelessness of a signal man at the Kansas City Union depot, in giving track clear for an incoming and outgoing train, resulted in a crossing collision.

BRIDGE ACCIDENTS are reported as follows: A bridge or trestle on the Georgia Central, near Albany, Ga., was struck by lightning recently, and badly damaged. A derailed freight car wrecked a small bridge or trestle on the Chicago, St. Paul & Kansas City near Lida, Ia., on Sept. 7. A burned bridge on the Union Pacific near Wyoming caused the wreck of a freight train Aug. 31. A bridge under construction on the Louisville & Nashville, near Elkmont, Ala., fell Sept. 2. The Cheesequake bridge at New Brunswick, N. J., has been destroyed by the storm of this week, and several railway trestles, bridges and culverts have also been damaged or destroyed.

A VERY HEAVY STORM on the Atlantic coast this week has done an immense amount of damage to buildings, beaches and property in general. The summer resorts, especially on the southern New Jersey coast, have suffered severely. At Atlantic City the low land between the beach and the mainland was flooded, the railway tracks washed out and communication cut off. High tides, heavy rain and strong wind have prevailed in the neighborhood of New York, causing much damage.

THE HEAVY BLAST mentioned last week (page 217) was at South Bethlehem, N. Y., and not at Selkirk, N. Y., as stated. An illustrated description of this great blast will be given next week.

THE CITY COUNCIL OF WINNIPEG, MAN., has extended to Oct. 1 the time for receiving propositions for the development of the Assiniboine water-power. An offer from the Assiniboine Water-Power Co. has just been rejected by the City Council. Its provisions were that the company would construct and maintain a dam and tail-race, and furnish the city with power, to the amount of 500 H. P., at 5 cents per H. P. per day, and also furnish power for business enterprises at a rate not exceeding $30 per H. P. per year.

THE PASSENGER RATE-WAR on Chicago-Cincinnati traffic has come to an end. Reports are contradictory as to which company struck the first blow; but it is certain that the fight should never have been started.—The Duluth, South Shore & Atlantic announces a through rate of $24 from Duluth to Boston and corresponding cuts to other points.—The prospects of securing an alliance between the trunk lines and Chicago-St.-Paul railways, to meet the Canadian Pacific's rates on through traffic from the seaboard to St. Paul, seem no better. As the Canadian Pacific will certainly meet all reductions which may be made, and as the shippers of the Twin Cities are friendly to the Sault route and jealous of the Chicago lines, the prospect seems to be that the bulk of the through traffic to St. Paul and Minneapolis will be relinquished to the Sault route and the water lines on the lakes.

THE CINCINNATI, WABASH & MICHIGAN railway, extending from Anderson, Ind., north to Benton Harbor, on Lake Michigan, according to a press dispatch, has been bought by D. J. MACKEY to form part of the Evansville & Terre Haute system, which has already an extent of over 1,000 miles. A link of 32 miles will be built from Anderson south to Rushville to connect the road with the Evansville & Richmond railway, now under construction.

THE INMAN LINE STEAMSHIP *City of New York* made a very creditable run on her last trip, reducing her record to 6 days, 4 h., 17 min. This is 10 h. 3 min. less than her previous best record. The *City of Paris*, which now holds the championship, made her last trip eastward in 6 days, 3 h., 58 min.

THE CHICAGO, MILWAUKEE & ST. PAUL has declared a 2½ per cent. semi-annual dividend on its preferred stock; and has issued a statement showing that the company has a handsome surplus left after the payment of this dividend, with the best business of the year yet to come.

THE ROADMASTER'S CONVENTION, at Denver, has elected officers as follows: President, JOHN SLOAN, Ohio, Ind. & W. R. R., Indianapolis, Ind.; Vice-Presidents, W. H. COURTNEY, Lake Shore & Mich So'n., Erie, Pa.; JOHN DOYLE, Det., Lansing & No'n, Iona, Mich.; Sec. and Treas., JOHN P. RAMSEY, Cinn., Ham. & Dayton, Connersville, Ind. Detroit was named as the place of the next annual meeting.

A Remarkable New Motor.

The very interesting new hot-air engine, illustrations of which are given herewith, is a prime mover which deserves the attention and study of every mechanical engineer. That it is indeed a remarkable motor will certainly be conceded when we say that it operates without valves or exhaust; and in fact works in a complete cycle, using the same air over and over at each stroke, and except for a small amount of leakage would run indefinitely by the simple application of heat and the cooling medium.

The illustrations given herewith, present detailed views of the complete engine; but its construction is such an innovation on all the ordinary types of prime movers that, while the operation of the machine is in reality extremely simple, it appears at first sight to be somewhat complicated. The working of the motor may be readily comprehended, however, by reference to the accompanying diagrams.

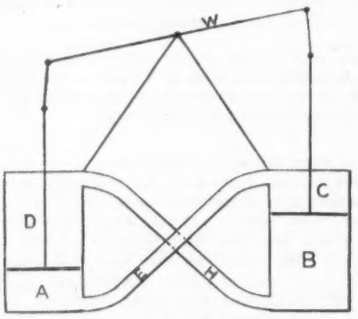

Fig. 1. Diagram of Hot Air Engine.

In Fig. 1 let *D A* and *C B* be two cylinders in which work pistons connected to the walking-beam *W*. Let the lower compartment of one cylinder, *A*, and the upper part of cylinder *B* be connected by an open pipe, *E*, and let *B* and *D* be similarly connected by the pipe *H*. If *A B C D* are all filled with air at a uniform temperature and pressure, the machine will be in equilibrium. Let now the air in chamber *A E C* be heated, and the air in chamber *B H D* be cooled. The left-hand piston will be driven upward and the right-hand piston down, and a force will be generated. When the stroke is completed, suppose the air in *A E C* to be cooled, and that in *B H D* to be heated, motion in the opposite direction will take place.

This simple principle is the one on which the engine shown in our engravings operates. In Fig. 3, the side elevation of the engine, the two working cylinders, *D D*, with their piston-rods connected to the walking beam, are seen. It is the alternate raising and lowering in temperature of the same body of air which causes a pressure to be exerted on the pistons in these cylinders to drive the machine.

But the question which every engineer at once asks is, How is it possible to so suddenly heat and cool this air as to make the motor a practical one? The difficulties in performing this feat seem so insurmountable that it is wonderful that any inventor should have been sanguine enough to attempt to accomplish it.

How it is done will be readily understood by reference to Fig. 2, which is a diagram of the cross section of one working cylinder and the mechanism employed to heat and cool the air which drives it.

In Fig. 2, *D* is the working cylinder, which, for simplicity is shown open at the top. C C' is a cylinder called "the reverser" connected by the pipe *G* with the cylinder *D*. E E represents the "regenerator," which consists of many layers of wire gauze wound round the cylinder, completely filling the space between the inner and outer cylinders as shown. *F F* are cooling tubes, open at the ends, and surrounded by cool water. A is the furnace grate, and B the heating surface by which the fire in the furnace heats the air in the reverser cylinder.

The only communication between the space C' above the reverser piston (the cold chamber) and the space C below (the hot chamber) is through the regenerator *EE* and cooler *FF*. Now when the reverser piston moves up, the cool air in C' is forced down through the tubes *FF* and regenerator EE, taking up by its passage through the latter a large part of the heat left in it by the preceding stroke, and receiving a further increment of heat from the furnace. Now this movement of the reverser piston evidently does not affect the volume of the air in the space C C' G D, but it has caused it to heat and tend to expand, thus producing a pressure which acts on the working piston D. When the reverser piston moves back toward the bottom of the cylinder, the body of air in C has to pass up through the regenerator, depositing a large portion of its heat there, and thence through the cooling tubes, where a good part of the remaining heat is taken up by the circulating water. The cooling of the air decreases the pressure on the under side of the working piston D, and it is forced down by the pressure from the other reverser cylinder.

By reference to Figs. 4 and 6 it will be seen that the top of each reverser cylinder is connected to the top of the working cylinder diagonally opposite, giving practically the same connections of the two working cylinders as that shown in diagram in Fig. 1.

It will be seen that the only office of the reverser piston is to alternately heat and cool the air, and that, except for the friction of the air in passing through the regenerator and cooler, the pressures on each side of the piston are practically equal. The reverser piston is driven by a walking beam, arm connecting rod, and crank, the latter on the main shaft.

Fig. 6, the section through the centers of one reverser and working cylinder is now easily understood. The fuel on the grate *A* gives off its hot gases of combustion, which circulate up around the heater *B B*, pass down the pipe *H*, around the working cylinder *D*, and out through the passage *H* to the chimney. Although the heater is made of heavy cast iron, it transmits the heat to the air in *C* with surprising facility, and does not get above a black heat when the engine is running. *E E* is the regenerator and *F F* the coolers. The latter receive and discharge water through the pipes *I I*. *K K* are pipes leading from the cool chambers of the reverser to the upper chambers of the working cylinders.

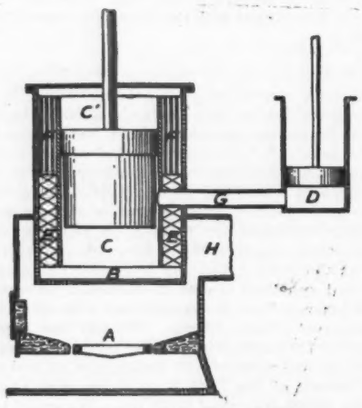

Fig. 2. Diagram of Reverser.

Another most important feature of the engine is the fact that it uses air compressed to a pressure of four or five atmospheres. An eccentric on the main shaft drives a small air pump which is connected to a reservoir, where the compressed air is stored, and is delivered to the engine fast enough to compensate for the slight leakage about the piston rod packings and at other joints.

The engine illustrated in Figs. 3, 4, 5 and 6 is is a 35 H. P. machine, which has now been running at the works of the Downer Kerosene Oil Co., at South Boston, Mass., for about a year. It is the latest and most improved type of engine which the inventors have yet built.

In March, 1889, Mr. GEO. H. BARRUS, M. E., of Boston, conducted a series of tests upon this engine to determine its economy in the consumption of fuel. His report, which we considerably condense, gives the following further description of the machine and account of the results obtained by the tests.

The regenerator consists of an annular space 3¾ ins. wide and 16 ins. high, the outside diameter being 29 ins. and the inside diameter 21½ ins., which is filled with wire gauze. This gauze is made of wire No. 25 B. W. G., which is about 1-50 in. in diameter, 12 meshes to the inch each way, and it is placed in the regenerator in such a way as to completely fill the space. It is wrapped spirally around the center cylinder, and there are 102 courses. The amount of the superficial area of this gauze before it is introduced is approximately 1,900 sq. ft.

Each cooler consists of 640 tubes, made of copper, 18 ins. long, 9-32 in. inside diameter, and No. 20 B. W. G., this last corresponding to a thickness of .035 ins. The air passes through the inside of the tubes, and the water which is used for cooling circulates around the outside. The tubes are held by means of heads 1¼ ins. thick, and the amount of surface exposed to the air between the heads is 60.8 sq. ft. on each side.

The engine is fitted with a governor, shown in drawing No. 1, which is of the ordinary centrifugal type. It acts upon a valve that opens communication between the top ends of the two working cylinders and thus tends to equalize the pressure in them.

The crank which drove the reverser pistons during the test was set about 70° ahead of the crank which is driven by the working pistons. The No. 1 reverser is at the top of the stroke when the No. 2 piston has moved over 56 per cent. of its down stroke, and the No. 2 reverser is at the top of its stroke when the No. 2 piston has moved over 40 per cent. of its down stroke.

The draught of the chimney for the engine is regulated by hand, a damper being placed in the flue leading from each furnace. The engine is arranged so that it can be worked at any desired initial pressure of the air, a pressure tank being provided, which is kept supplied with air by means of a small air compressor, which is worked by an eccentric on the main shaft, shown in Figs. 3 and 4. The diameter of the cylinder of this compresser is 4 ins. and its stroke 6 ins., and it is single-acting. The dimensions of the pressure tank are, diameter 24 ins., length 5 ft.

This engine is built for a working pressure in the tank of nominally four atmospheres, that is, 45 lbs. by the gauge; but it has been worked for a short time at a pressure in the tank of five atmospheres. It is claimed that there is no limit to the pressure which can be carried in the machine, except that which relates to the strength of the parts. The pressure in the tank is that of the lowest pressure in the engine, corresponding to the back pressure in the ordinary steam engine, and the heating of the air serves to carry the highest extreme of pressure above this point. The pistons of the engines for the working cylinders are packed with simple cast-iron ring packing, each set out with springs. It will be noticed, by referring to drawing No. 3, that the pistons of both cylinders are very deep, the packing being located on the top, and this provision is made so as to keep the rubbing surface of the packing as far as possible away from the hot end of the cylinder.

The lubrication of the cylinders is effected by means of cylinder oil in the manner of ordinary steam engines, though the oil requires to be pumped into the cylinders rather than fed automatically.

The furnaces are lined with fire brick, and beyond this there is no protection against radiation, all the cylinders and exterior of the furnaces being bare. The engine which was tested—that is, the No. 13—occupies a floor space of 7.1 x 11.6 ft. The extreme height over all is 10 ft. and the weight, as given the writer by the manufacturers, is 12 tons.

Table of Dimensions of No. 13 Engine.

Working cylinders, 12½ in. diam. 18-in. stroke	2	
Reverser cylinders, 20-in. diam 16-in. stroke	2	
Total area of grate surface, both sides	3.3	sq. ft.
Heating surface, each heater, exposed to furnace	17.3	"
Heating surface beneath each working cylinder	6.8	"
Total heating surface, both sides both cylinders	48.2	"
Smoke stack; diam., 16 ins.; height 40 ft	16	in.
Inside diameter pipes connecting reverser cylinders and working cylinders	3½	"
Reverser displacement, one stroke, each side	4,987	cu. in.
Reverser displacement, per revolution, both sides	19,948	"
Working cylinder displacement, one stroke, one side	2,198	"
Working cylinder displacement one revolution, both sides	8,792	"

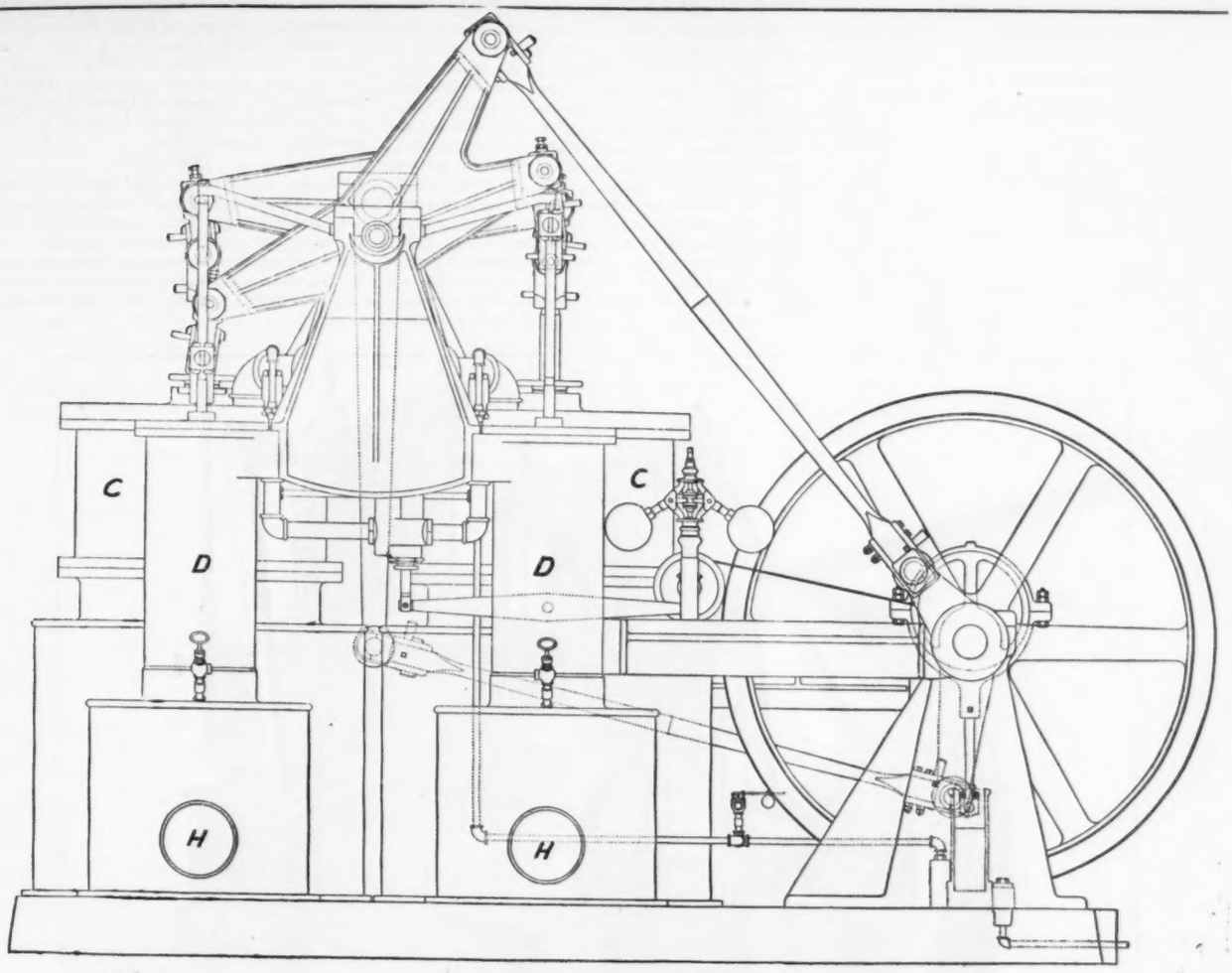

Fig. 3. Side Elevation.

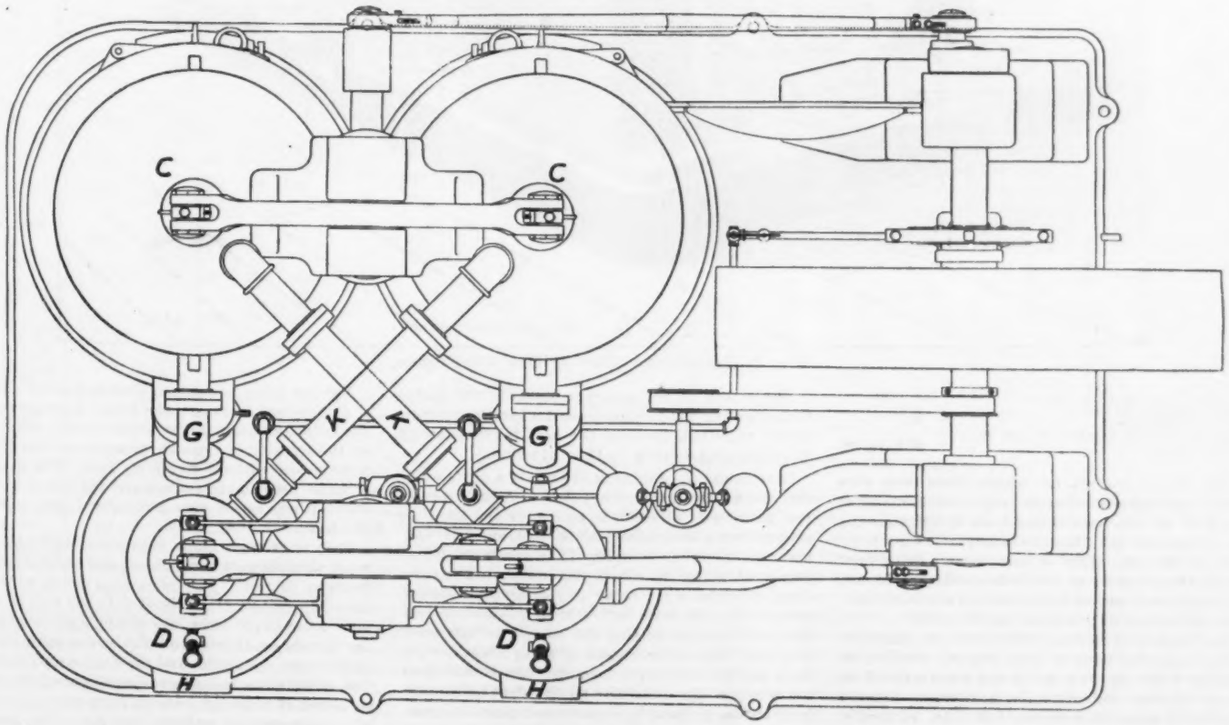

Fig. 4. Plan

A Remarkable Hot Air Engine.

Total volume of air in engine	28,172 cu. in.
Ratio total volume of air in engine to displacement of one stroke of two reversers	2.82 to 1
Weight of air heated and cooled in 10 hours, app	204,270 lbs.
Horse-power constant for 1 lb. M. E. P., one revolution per minute each cylinder	.0111 H. P.
Dead air space in complete engine, that is, total volume of air minus volume of reverser displacement, 2 cylinders, 1 stroke, and minus working piston displacement, 2 cylinders, 1 stroke	13,801 cu. in.
Dead air space for one side	6,900 "
Annular regenerator space, 16 ins. long	3½ in. thick
Area of wire gauze with which regenerator is filled	1,900 sq. ft.
Area exterior surface wire gauze in each regenerator, app	2,765 " "
Number of tubes in cooler, each side	640

mmunication with each other by means of a valve, usually called the "by-pass valve," placed in a connecting pipe. In starting the engine from a state of rest, this valve is closed, and the fly-wheel is turned by hand till the working pistons pass their dead centers, and after this the engine moves off in the same manner as an ordinary steam engine. The engine is worked on common air for, say, half an hour's time, till the heaters have become thoroughly warmed and the regenerators brought to normal action. Then connection is made with the pressure tank, and whatever pressure it is desired to run upon is allowed to enter the machine. A safety valve on the pressure tank, which can be set at any desired point, enables the desired pressure to be obtained.

necessary, all danger of injury will be prevented by covering the fire with a bed of ashes. When the engine is finally brought to rest, it is simply necessary to open the by-pass valve, and thereby open communication between the two working cylinders, by which means the pressure in the entire engine is brought to an equilibrium.

THE TESTS.

The tests had for a principal object the determination of the consumption of fuel per indicated and net horse power per hour. Stated briefly, they embraced several runs, made with the engine driving one or both the fans referred to in the usual manner, during which the indicated horse power, the weight of fuel burned, and some other observations were obtained.

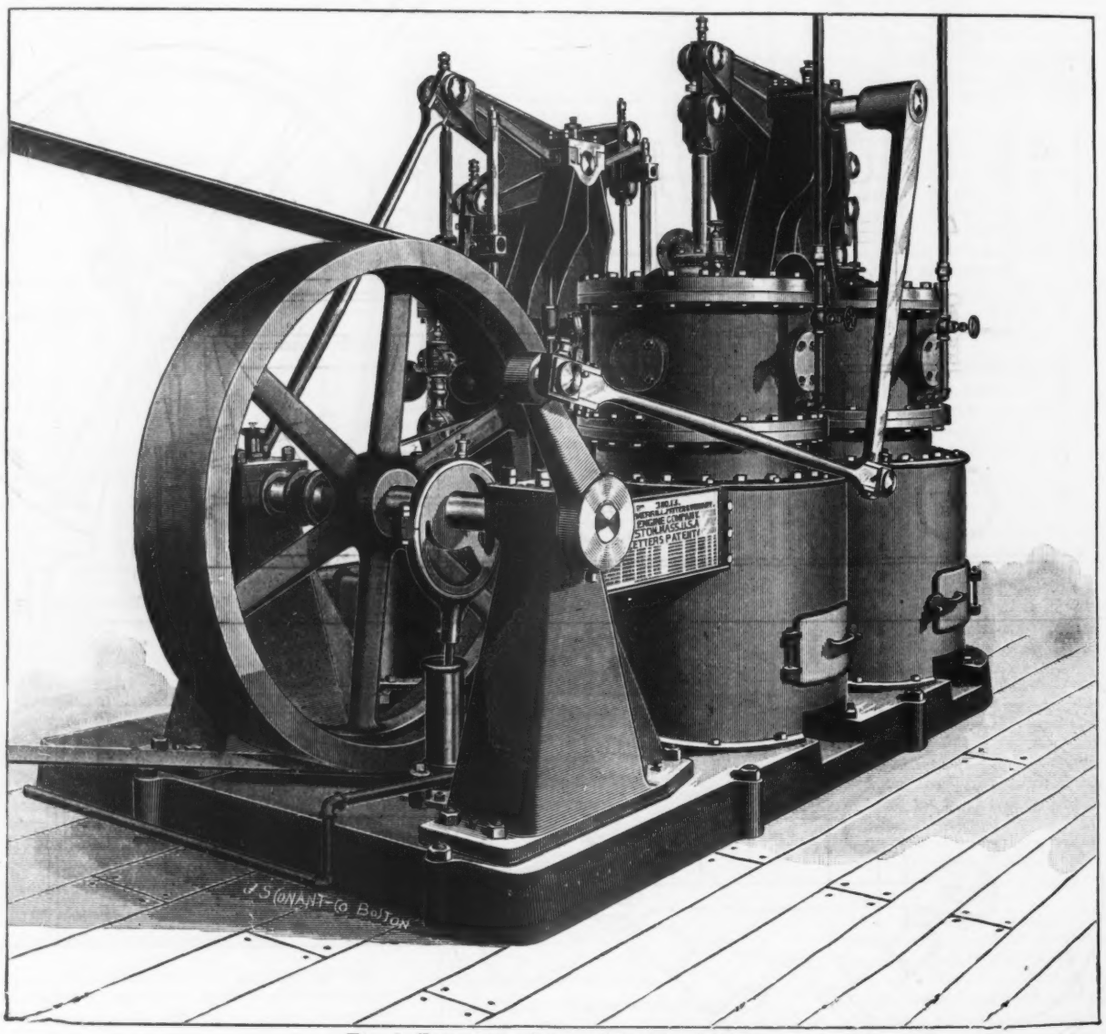

Fig. 5. Perspective View of Hot Air Engine.

Length of tubes between heads	15.5 in.
Inside diameter of tubes	9-32 "
Thickness of tubes	.035 "
Area of surface exposed to air in each cooler	60.8 sq. ft

The No. 13 engine, on which these tests were made, has been erected about eight months, and at the time of the tests it had been in operation for the purpose of exhibition or experiment for a large part of the time since it was built. Being used simply for purposes of exhibition and experiment, the engine is employed in driving an artificial load, this load consisting mainly of fan-blowers.

The process of setting this form of engine to work, beginning with a cold engine, consists in making a fire on the grate in the same manner as in any furnace, and after the heater has become thoroughly warmed, requiring less than an hour's time, the engine is set to work on "common air," as it is termed, being disconnected from the pressure tank. When the engine is at rest, the top ends of the two working cylinders are put in open

The action of the governor prevents the engine from running at too high a speed when the pressure is first admitted, provided the heat is great enough to produce a tendency in this direction.

In stopping the engine at the end of a day's work, the fires in the furnaces are first burned down to a low point and allowed to go out, or the fires are covered with fresh coal and banked, and the temperature thereby reduced. It is desirable, before finally stopping, to allow the engine to run for a time on common air, so as to reduce the temperature of the machine before it is brought to rest. It is not desirable to stop the engine for any great length of time in the middle of a day's work, when there are hot fires in the furnaces; but a stop for a few minutes' time produces no disorder and is unobjectionable. It is to be remembered that the maintenance of a continuous hot fire, with the engine at rest, would gradually heat the whole machine to a high point, and, of course, produce injury. If, however, a stop of more than a few minutes becomes

The net horse power was determined by making a comparison between the brake horse power and the indicated horse power under various conditions, on the occasion of some supplementary tests, which were made without weighing fuel. The quantity of water used in the coolers and the temperature to which it was raised were determined only on two of the tests.

Two tests were made, beginning with the time when the fires were first lighted, and the engine again brought to rest. The remaining tests, which are three in number, commenced with the fires in a normal condition of work, the engine also running under normal conditions, and they ended with the fires in the same condition, and the engine still running. One of the three last-named tests, that of March 23, consisted of a period selected from one of the tests which commenced with the new fire. The manner of conducting the tests will, in the main, be seen from the detailed record of the data and results given in the following table, appended to which is

a copy of the sample diagrams taken during the test of March 23.

The indicated horse power was obtained from diagrams taken from a single indicator applied to a three-way cock, connected to the top ends of the two working cylinders. The diagrams were taken every twenty minutes. It is assumed that the diagram taken from the top end of one cylinder gives not only a representation of the power developed at that point, but also a fair representation of the power developed at the bottom end of the opposite cylinder. Experiments which the writer has made on one of the earlier engines of this type show that this assumption is in substantial accord with the facts. The indicator used was one of the Tabor pattern, having a well-fitted metallic piston.

RESULTS OF ECONOMY TESTS.

	GAS-HOUSE COKE.				Geo. 's Cr'k & Cum'd Coal.
Date of Test.	March 5.	March 6.	Mar. 23.	Mar. 23.	Mar. 25.
Quantities.					
Weight of dry fuel consumed per hour, lbs.	48.9	55.0	60.2	50.0	52.5
Indicated H. P. developed by engine according to G. H. B's Indicator, H. P.	30.16	29.68	31.45	32.38	32.43
Brake H. P. developed by engine assuming friction of 11.26 H. P. as determined by brake tests, H. P.	18.90	18.42	20.19	21.12	21.17
Coal burned per I. H. P. per hour, lbs.	1.62	1.85	1.91	1.54	1.62
Coal burned per Brake H. P. per hour, lbs.	2.59	2.99	2.98	2.37	2.48
Water passing through coolers per hour, computed from results of the one-minute observations, lbs.	4,458	3,612	.....	.....	.....
Units of Heat absorbed per hour by water passing through coolers, H. U.	284,854	241,281.6	.....	.....	.....
H. U. absorbed by coolers per I. H. P. per hour	9,444.7	8,129.4	.....	.....	.....
Heat derived from fuel per I. H. P. per hour, supposing 1 lb. of fuel gives to the engine 9,000 lbs.	14,580	.....	.....	.....	.....
Heat converted into work per I. H. P. per hour	2,564.8	.....	.....	.....	.....
Averages of Observations.					
Air pressure in pressure tank,* lbs.	42.5	44.4	46.6	46.7	.....
Temperature of air leaving bottom No. 2 reverser	612°	569°	564°	574°	610-620°
Temperature of air leaving No. 2 cooler.	140°	134°	136°	136°	133°
Apprx. number of degrees air in No. 2 reverser is heated and cooled.	472°	435°	428°	438°	‹82 [?]°
Temperature of water entering coolers	36°	36°	30°	39° apprx.	42.5° approx.
Temperature of water leaving coolers.	99°	102.8°	97°	98°	101°
Number of degrees by which water is heated.	63°	66.8°	58°		
Indication of gauge attached to Indicator pipe, No. 2 cylinder from 10 A. M. to 4.30 P. M., Mar. 6, lbs.	.....	42 to 67.7= 25.7	.....	.....	.....
Extreme pressures shown by Indicator diagrams from 10 A. M. to 4.30 P. M. Mar. 6 lbs.	.....	42.4 to 65.1= 22.7	.....	.....	.....
Revolutions of engine per minute.	113.1	112.4	112.5	113.6	108.4
Mean effective pressure measured from diagrams,† lbs.	12.02	11.90	12.60	12.84	13.48

NOTE.—Temperature of escaping gases, one observation, March 6, 600 + degree.

* Above atmosphere.

† G. H. B's Indicator.

The comparison between the brake horse power and the indicated horse power was made on March 7 and March 22. For this purpose the belt was removed from the fly-wheel and a Prony brake was substituted. Before applying the load, the engine was well warmed up. When the load was finally applied, the brake was screwed down till it lifted a certain weight, determined upon beforehand, and when the speed had become uniform, several sets of diagrams were taken. These tests were necessarily of short duration, no provision having been made for cooling the fly-wheel and absorbing the heat produced by friction. But they were of sufficient duration to obtain satisfactory indications of the desired results. The brake ran smoothly, and there was no uncertainty as to the indications.

In connection with these brake tests, indicator tests of the power developed by the engine with no load were made, first with the engine running on common air, and second with the engine running on a pressure of about 40 lbs. in the tank.

The average of the friction tests shows that when the engine develops 31.18 indicated horse power, the brake horse power is 19.92, and the power absorbed in the friction of the engine is the difference of these quantities, or 11.26 H. P. It will be seen that this quantity is in excess of the friction determined by the indicator, with engine working on common air, and it is considerably less than the friction thus determined when the engine was running under pressure. The excess shown by the brake tests over the indicated friction on common air can be attributed to the increased friction due to the greater density of the air under pressure.

It is not easy to account for the relatively small amount of friction shown by the brake, compared with the indicated horse power of the same, working under pressure, a difference of over 4 H. P. It should be observed that the test of friction by the indicator under pressure was made with a comparatively cold engine, the temperature being only 385°, whereas the ordinary working temperature is in the neighborhood of 600°. This, however, does not furnish a satisfactory explanation.

COMMENTS ON THE RESULTS.

Mr. BARRUS judges that the 10 hours' test of March 23 gives a fair indication of the capability of the engine in the matter of economy of fuel, when that fuel is gas-house coke, under the conditions which obtained on the test. The two previous tests of March 5 and 6 were made with coke which was wet. The test of March 23 showed that the fuel burned per indicated horse power per hour amounted to 1.91 lbs., and that burned per brake horse power, assuming a friction of 11.26 horse power, as shown by the average of the brake tests, was 2.98. The results of these tests show that the engine is capable of transmitting through the belt an effective horse power for not more than half of the coal required for the best steam engines of small power, which are commonly used, the assumption being made that ordinary engines of this size use about 5 lbs. of coal per indicated horse power, per hour, and about 6 lbs. per brake horse power.

These results do not appear to be the best that can be obtained from this type of engine, for there is a considerable loss of heat from the unprotected exterior surfaces of the furnaces, due to radiation, which might easily be prevented by the use of suitable covering. There is also loss from the exterior surfaces of other parts of the engine, from the same cause, which might also be prevented. It is be-

Data and Results of Part of the Friction Tests.

Pressure in tank above Atmosphere lbs.	Temperature of air leaving bottom No. 2 Reverser	Rev. of Engine per Minute.	Set weight on the Brake Arm.* lbs.	Indicated H. P. developed by engine.	Brake H. P. developed by Engine
43.5	600	108	288.1	30.87	19.75
45	630	108	302.6	30.16	19.79
46	600	103	282.6	29.56	18.48
46		104	383.1	36.52	25.30
47	630+	103	372.1	35.74	24.34
46	565	101	248.1	28.27	15.91
Average				31.18	19.92

* Length of brake arm equals 3 ft. 4 ins.

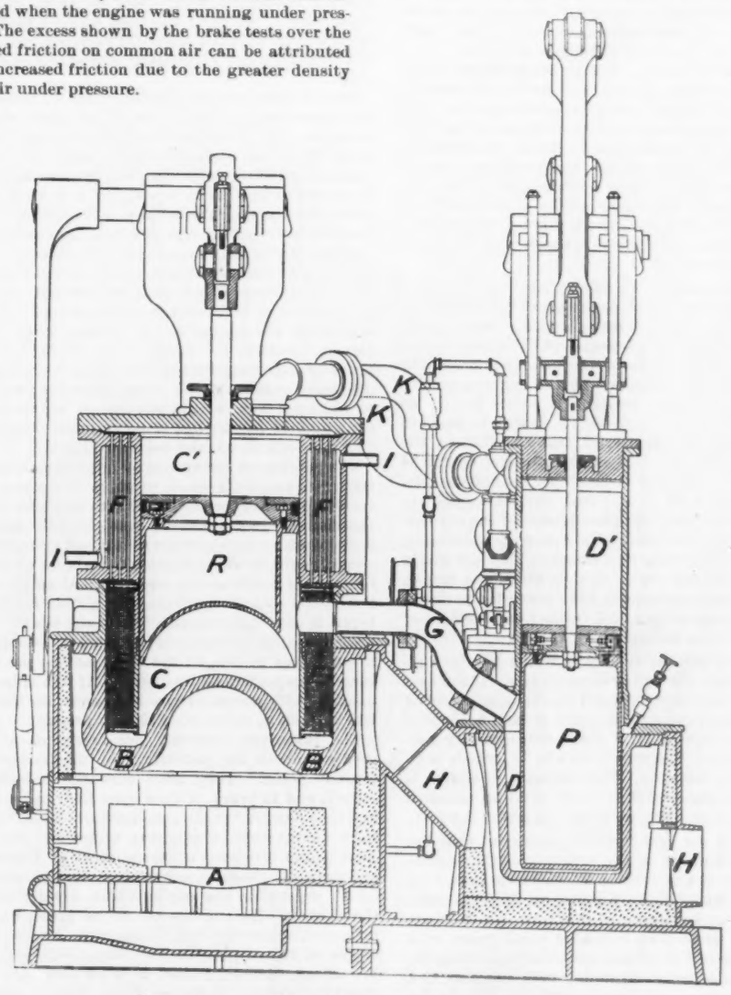

Fig. 6. Cross-Section of Hot Air Engine.

lieved, also, that the engine is capable of giving better results with some changes in the proportions. This opinion is offered for the reason that the present engine is so far in advance in the matter of economy of fuel over a previous engine, which Mr BARRUS tested several years ago.

It may not be uninteresting to make a comparison between these results and the former ones, and show wherein the improvement has been produced. In the earlier engine, the consumption of anthracite coal per indicated horse power per hour was 4.4 lbs., which is equivalent to 7.3 lbs. per brake horse power per hour. The engine was somewhat smaller; the working cylinders being 10½ ins. in diameter and 18-in. stroke; and the pressure in the tank was somewhat less, being 34 lbs. An examination of the former engine shows that the area of the surface exposed to the air by the regenerator was 282 sq. ft., whereas, in the No. 13 engine, the area of surface in each regenerator is 2,865 sq. ft., or nearly 10 times as much.

It appears that the relative proportions of the reverser cylinder and working cylinders are somewhat different in the new engine from those in the former one. But the principal difference is in the change in regenerator surface. It is not improbable—indeed it is quite certain—that a still further increase of regenerator surface would be advantageous. The very large proportion which the volume of the total quantity of air in the engine bears to the volume of the reverser displacement is noteworthy; and it would seem that if this proportion could be reduced, the efficiency of the engine might be increased. It may be difficult to secure very much reduction in this direction, but whatever change could be made would be desirable.

If we assume that 1 lb. of fuel, used on the test of March 5, gave up to the engine a total of 9,000 H. U. of heat, this amount being all that could probably be realized from a pound of coke, considering the high temperature of the escaping gases, the amount of heat consumed by the engine per indicated horse power per hour is 14,580 H. U. as given in line 28 of Table No. 2. It will be noted in line 27 that the quantity of heat absorbed by the coolers and carried to waste from the engine is 9,444.7 H. U. This is about 65 per cent of the estimated total heat of the coal, and this quantity represents the loss due to inefficiency of the regenerator. It is evident that, with a perfect regenerator, the saving of fuel due to overcoming this loss would amount to 65 per cent., and, as intimated before, there is ample opportunity to improve the performance of the engine by a still further enlargement of the regenerating surface.

The loss of heat by radiation, which has been referred to, is shown by the same figures. If the heat converted into work is added to the heat absorbed by the coolers, the total amount of heat accounted for becomes 12,009.5 H. U.; and this quantity subtracted from 14,580 equals 2,570.5 H. U., which is attributable to radiation. This estimate, of course, is approximate, because it is based upon an assumed quantity of heat given up to the engine by the coal.

In view of the very large improvement that has already been made in the economy of the engine, and in view of the evident losses which have been referred to, which are still going on, it seems quite probable that an engine of this type can be made which will develop an indicated horse power on a consumption of 1 lb. of coal per hour, measuring the coal during a period beginning with the fires in a normal condition and ending with the fires in the same condition. This is one-third less than the results of the tests of March 23d, giving 1.5 lbs. of coal per indicated horse power per hour.

So far we have merely abstracted Mr. BARRUS' report, which seems a sound and careful one. The economy shown in these tests is very noteworthy; but the great point of interest is the future development of which the engine seems capable. The inventors have done admirably in placing on the market a new motor, in every step of the design of which new difficulty had to be met and new problems had to be solved, and have done wisely in delaying its introduction until it could fight its way on its merits; but we have little doubt that the engines of this type yet to be built will show as great an improvement over this as this shows over the dozen experimental engines which the inventors have already built.

Considering, however, the existing type of machine which the inventors propose soon to place on the market, it is evident that it presents some strong claims to the favor of users of power. In the first place, it is absolutely safe. The compressed air, even if it were worked at three times the pressure, could do little damage in case an explosion occurred. It is the water in a steam boiler that makes its giving way so disastrous. This is an especially important feature in cases where power has to be generated in the basements of large structures, where a boiler explosion means an enormous destruction of life and property.

In the second place, it is economical. The motor can be built as cheaply as a steam engine, even in these days of low-priced engines, and it will run on a smaller amount of fuel than any steam engine. This seems well settled by Mr. BARRUS' tests. The water for cooling can be used over and over again by the provision of a cooling tank, and need not cost nearly as much as the supply for a steam boiler does. As for minor good points, it is noiseless, cheaply lubricated, very steady in speed, and we should think would be the most durable motor in existence, there being no boiler to corrode, leak, and render itself a general nuisance and source of worriment.

Probably the greatest obstacle that its inventors will meet in its introduction is the space that it occupies. It is true that it occupies not much more room than the combined engine and boiler of a steam plant of the same size; but the machine is an indivisible whole in this case, and it is often most convenient to have the furnace and boiler and coal bunkers considerably removed from the engine.

If the engine can be increased in economy so as to generate an indicated horse power per hour on 1 lb. of coal, motives of economy will be apt to override motives of convenience, and in many cases they will with the engine in its present state. Certainly, however, the chances for its further improvement, as suggested by Mr. BARRUS, seem good. The main point in which improvement is needed is to make the same weight and size of engine generate a greater power; but possible improvements in fuel economy should also be looked after.

The point most susceptible of improvement about the whole engine, it seems to us, is the ratio of the volume of the reverser cylinders to the total air in the engine. In its present condition the machine has to work under about the same disadvantage that a man would be who should try to walk on a surface like that of a woven wire mattress. At each stroke the heated air has to compress a big "air cushion" before it can "get a bearing" to do any work. The great disparity between the indicated and the brake horse power is due to the fact that the motor is large in proportion to its power. If the same size machine will generate twice the power, its friction loss will not be much more than at present.

The inventors, however, are deserving of the greatest credit for perfecting the machine to its present point. They have expended $150,000 in money, and 12 years of time upon their invention, and they deserve to reap good profits from it. They have incorporated a company under the laws of New Hampshire with a capital stock of $1,000,000, and propose as soon as sufficient capital is secured to fill orders for the engine which are already in their hands. The engines are to be made, we are informed, by the Taunton Locomotive Works. The offices of the company, whose official title is "The Woodbury, Merrill, Patten & Woodbury Air Engine Co.," are at 8 Exchange Place, Boston, and at Nashua, N. H. We acknowledge the courtesies of Messrs. WM. H. BILLINGS, Treasurer of the Taunton Locomotive Works, and JOSHUA MERRILL, one of the inventors of the engine, for information received.

In an early issue we hope to make some further comments on this new motor and on the chances which it seems to open up for replacing that most wasteful motor, the steam engine, with a more economical prime mover.

The Opposition to the Proposed Skaneateles Lake Water Supply for the City of Syracuse, N. Y.

The following is a correct statement, as we understand the facts (from the standpoint of those favoring the scheme) of the objections raised against a new water supply for Syracuse, N. Y., from Skaneateles lake, and the answers thereto. Although our sources of information are somewhat *ex parte*, yet we believe the statement to show the exact facts.

The law passed at the last session of the New York Legislature (chapter 728 of 1889), "To establish and maintain a water department in and for the city of Syracuse" provides that for the supply of the city so much water may be taken from Skaneateles Lake as may be necessary, on condition that the city shall, "when so required by the Canal Board, furnish from such source or sources and in such manner as the Canal Board may designate, as much water for the use of the Erie Canal as shall be taken by the city from Skaneateles Lake." The Water Board having become satisfied from the examination made by its engineer, Mr. J. J. R. CROES, that a compliance with the provisions of law was easily practicable, made formal application to the Canal Board on Aug. 29, for its consent. The case was presented at a public meeting in the Assembly parlors in Albany, there being present of the Canal Board, the Lieutenant Governor, the Comptroller, the Treasurer, the State Engineer, and the Attorney General. Two members of the Board, the Secretary of State and the Superintendent of Public Works were absent.

The City's case was presented in an admirably lucid and concise manner by Mr. C. A. STONE, formerly City Attorney of Syracuse. His argument was based on the report of Mr. CROES to the Water Board which showed from the records and statements of the Superintendent and Engineers of the middle division of the Erie Canal, that during the 11 years from 1878 to 1889, covering a season of extreme and protracted drought, as well as one of great rainfall, the greatest draught on Lake Skaneateles for the Canal has never exceeded in any one year 48 ins. out of the 76 ins. which the lake may be lowered. The average annual lowering of the lake during the season of navigation has been 35 ins. During the five months that navigation is closed, and no water drawn from the canal, there is drawn every year from the lake for the supply of water-power to the 25 mills along its outlet, sufficient water to have raised the lake 30 ins., had it been retained in the lake. This water the State does not own and cannot retain in the lake.

The City of Syracuse proposes to extinguish the water rights of these mills and all riparian rights along the 9 miles of the creek between the lake and the canal, and then impound this water in the winter. It then proposes to draw from the lake a supply not exceeding 15,000,000 galls. per day, or enough to lower the surface of the lake 24 ins. in a year, thus actually increasing the storage supply for canal use by 6 ins., which is equivalent to 11 days' full supply to the Jordan Level. In addition to this the City proposes to restore to its full efficiency a neglected feeder to the Port Byron level from Owasco lake, the present condition of which obliges at least 20 ins. more in depth to be drawn from Lake Skaneateles than is really needed for the Jordan Level. In effect, therefore, the City of Syracuse, in consideration of being permitted to draw off 24 ins. from Lake Skaneateles, offers to add a storage supply equivalent to 26 ins. for canal use in addition to what it will take for city use, and to that now available. The practicability of doing this is stated to be shown graphically by Mr. CROES by profiles platted from the records of the Canal Department for the past 11 years.

These facts when presented, appeared to astonish the opponents of the grant of the required right to Syracuse, who seems to have come prepared with merely general objections to what was proposed. The opposition was represented before the Canal Board by a small deputation from Syracuse, claiming to represent the 900 voters, who had opposed at a special election the adoption of the Skaneateles project for water supply, the vote in favor of which was 11,300. There were also present some gentlemen from Buffalo, and a lawyer from New York, who stated that he represented the Produce Exchange. The Buffalo and New York opposition was mostly based on the assumption that the city of Syracuse proposed to take from the Erie canal, water which belonged to it, and which could not be replaced. A letter was also presented from Mr. HORATIO SEYMOUR, who at one time was State Engineer, and a long document was read by Mr. JOHN STEBBINS, the superintendent of that section of the Erie canal, making the same general claim that the canals would be injured, but not specifying in any tangible way how they would be injured. Considerable amusement was created by the fact that both of these documents, and also the arguments of the Buffalo and New York contingent were based upon certain clauses which did not appear at all in the bill as it was passed by the Legislature.

The opposition did not finally give up their case, however, but after consultation among themselves, asked the Canal Board to give them further time, which the Canal Board conceded in fixing Sept. 23 for another public hearing.

THE CORONER'S VERDICT on the death of the three persons killed by the bursting of the Spring Lake reservoir dam at Cranston, R. I. on Aug 28, declares that the dam was of defective construction.

The Nicaragua Ship Canal.

(WITH INSET.)

The work on this canal being now fairly begun, engineers in general will be greatly interested in the large colored sectional profile which accompanies this issue and which gives the first information as yet published of the precise nature of the material on the line, without which, of course, it is quite impossible to form very definite views as to the probable cost of the canal or the sufficiency of estimates.

We comment at some length on another page on the general status and promise of the enterprise as shown by this profile and other accompanying information, and in this article confine ourselves to a presentation of the facts which must form the basis of any opinion in regard to it, so far as they are as yet determined.

We published on July 14, 1888, a general summary of the results of the 1888 surveys, with maps and profiles. We reproduce in this issue three of these maps, with some corrections, viz., a general map of the entire route from ocean to ocean (Fig. 1) and detail maps of the Western Division (Fig. 2) and of the canal and basin part of the Eastern Division (Fig. 3). All the rest of the route consists merely of lake and slack-water river navigation.

Our large colored inset sheet shows, first, a general profile (A) of the entire route; and secondly, detail profiles to large scale of (B) the Eastern Division, Greytown to Deseado Basin; (C) Middle Division, Deseado Basin to San Juan River; (D) Crest profile of the crest and embankments which together form the San Francisco and Machado Basins; (E) Center line of San Juan River, showing the character of bottom and extent of dredging required; (F) Western Division, Lake Nicaragua to Brito.

On all these detail profiles the material is accurately indicated in a manner which, once comprehended by a brief study of the symbols, becomes very distinctive. Thus, *red indicates clay* wherever it appears. Red clay is shown by plain red; blue clay, by red striped with blue; yellow clay, by red striped with yellow; white clay, by red striped with white. *Yellow indicates sand*, gravel being indicated by black dots on a yellow base, and clay and sand mixed by red and yellow stripes crossing diagonally. *Loams* are indicated by black vertical stripes. If it be a clayey loam, these stripes are on a red base; if a sandy loam, on a yellow base.

The distinction between rock and earthy materials of all kinds is so distinctive as to be at once grasped by the eye, even without the aid of any special description. Thus it is hardly necessary to refer to the key at all, although 12 different kinds of material are indicated.

In reference to the character of the earths, we may say, from personal examination of the samples of borings, and from the universal testimony, that all the clays seem to be exceedingly retentive of water Even the mixed clay and sand seem to be an excellent natural puddle. The "loams" are all of them poor material to have about a canal bottom or dam foundation, and where they exist must be got out of the way. Fortunately, this material is not often encountered in objectionable positions, although some considerable deposits of it will be found under the embankment dams shown in Profile D.

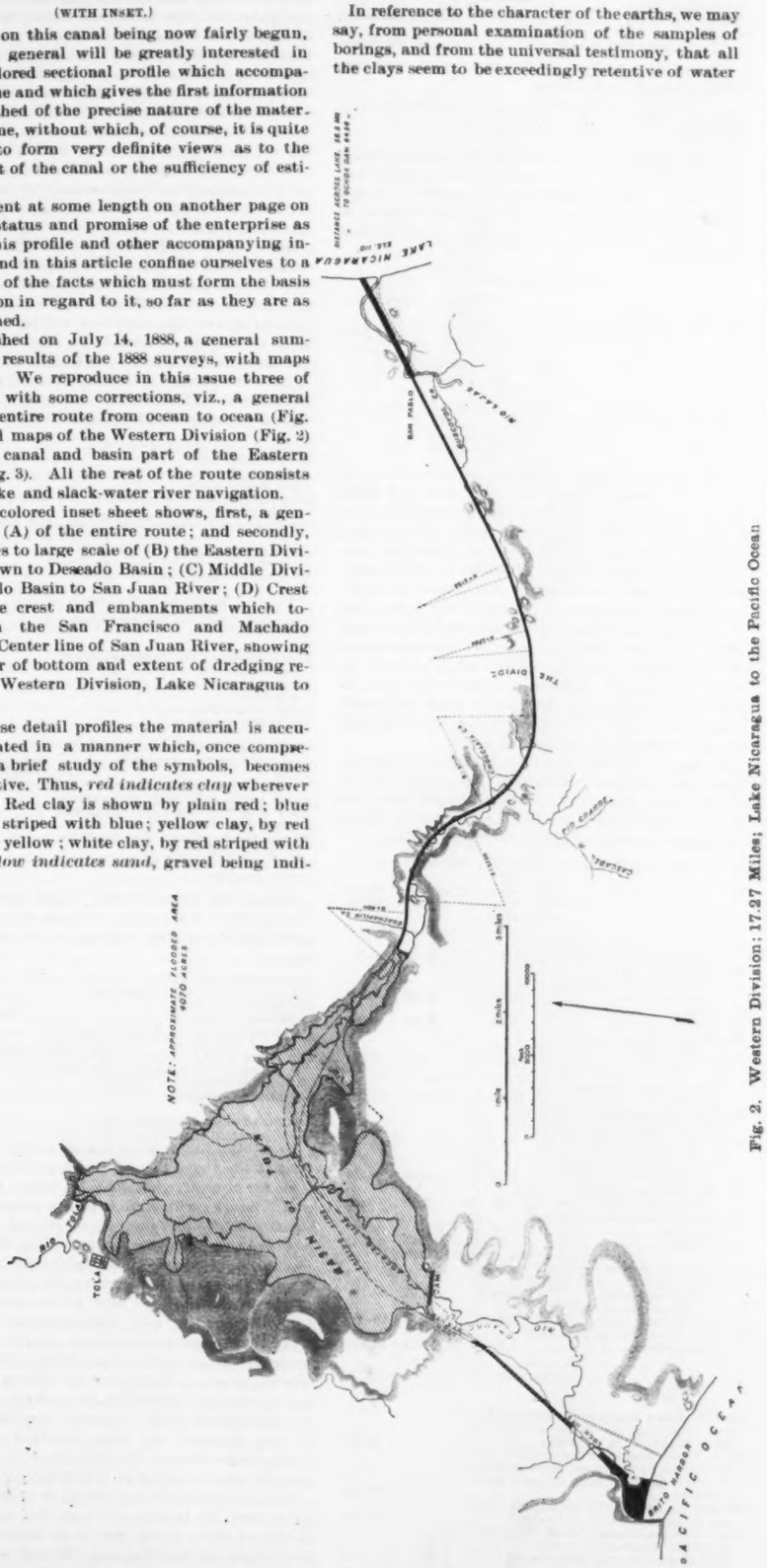

Fig. 2. Western Division; 17.27 Miles; Lake Nicaragua to the Pacific Ocean

Fig. 1. General Map of Entire Route from Ocean to Ocean.

NICARAGUA SHIP CANAL. A. G. MENOCAL, *Chief Engineer.*

The profile is reduced photographically from the very elaborate profiles which have been constructed by the company to the usual railway profile scales of 400 ft. per inch horizontal and 30 ft. per inch vertical. The reduced profile is to a scale of 3,000 ft. per inch horizontal or only $\frac{1}{7\frac{1}{2}}$ as large, and proportionately for the vertical scale, but as the reduction was wholly photographic the profile still remains minutely accurate, and may be enlarged to 7½ times its present size by a magnifying glass, or otherwise, and still afford as great accuracy as the original profiles. We think it but due to Mr. MENOCAL and his able staff of assistants to say that in a somewhat large experience with plans of this nature, we have never seen any which showed such signs of careful preparation; nor do we recall any large enterprise in which there has been any approach to equal pains to determine precisely what had to be done before attempting to do it.

The basis of fact on which the sectional part of the profile is constructed the reader has before him in the profiles themselves, where the position and depth of the borings taken is accurately indicated to scale by vertical black lines. A considerable number of additional borings were taken too far off the line to be shown on it, but with this exception all the borings taken appear, except along the bed of the San Juan river (Profile E), where they were not accurately located, nor were they as carefully made as the others, being confined for the most part to a superficial examination of the bottom by rods, all material which could not be thus penetrated being called rock. It is not claimed, therefore, that this profile is as precise as the others, but it is believed to err chiefly by showing too much rock.

The other borings on all the profiles were taken with boring tools adapted for penetrating earthy materials only, the assumption being everywhere that the material below the lowest point to which the boring could be pushed was rock. This tends to safety in the estimates by exaggerating, if anything, the amount of rock; and it is altogether probable that at a few points on the profile at least the amount of rock is less than is shown. On the other hand, in the foundations of the locks it would be a disadvantage if the material should not prove to be rock; but the only doubt in this respect is deemed to be in regard to Lock No. 1, Locks No. 2, 3, 4, 5, and 6 being quite certainly on rock, and the material under Lock No. 1 being at least hard material in which boring tools will not penetrate.

Further borings by rock drills through the entire depth, rock and all, are now in progress at the great eastern divide cut, and will afford details for the subdivision of the "rock" into at least two classes, rock proper and *talpetate* or *tepetate*, two materials which differ very much in hardness and cost of excavation. The rock proper is a very hard, unstratified volcanic rock, and of this the great rock cut in the eastern division is mainly composed, with a coating between it and the clay of *talpetate*. The last is a material we have often described, found only in volcanic countries, and supposed to consist of consolidated volcanic ash or mud. It holds a slope quite as well as rock, and also requires powder for its economical working, being sometimes hard enough to serve as a building material, but being much more cheaply excavated than ordinary rock, resembling in texture and hardness a very much under-baked brick more than any other material with which we are familiar. Immense deposits of it exist throughout Mexico and Central and South America. It will evidently tend to reduce the cost of the work quite sensibly should there prove to be a considerable percentage of this *talpetate* in the material shown as "rock" on the profile, but for the present this contingency is neglected.

The extraordinary natural advantages of this route, as shown by the large proportion of it on which there is a natural slack-water navigation, will be seen by a glance at the upper (general) profile on our colored sheet, on which all this class of navigation is colored blue, and all that part requiring canal excavation colored orange. In the aggregate there is:

	Miles.	
Canal in Excavation—East Side	16.048	
" " " West Side	11.160	
" " " Six Locks	0.759	= 27.907 miles.
Basin of the Deseado	4.220	
" of the San Francisco	11.368	
Basin of Tola	5.504	= 21.092 miles.
River San Juan	64.540	
Lake Nicaragua	56.500	= 121.040 miles.
Total Length of Route		170.099 miles.

Contrasting this with the two great previous canal enterprises, we have:

Suez	Route	99.2 miles long,	65	miles	Canal Exc.
Panama	"	46.5 "	46.5	"	" "
Nicaragua	"	170.1 "	27.9	"	" "

Thus, although the Nicaragua route is the longest of the three, owing to a long, unbroken stretch of 121 miles of free navigation in the midst of it, the length of *canal proper* is by far the shortest of the three. By percentages we have the following comparison:

Nicaragua Canal.

	Miles.	Per Cent.	
Canal in Excavation	27.907	16.4	
Free Navigation, basins	21.092	12.4	83.6
" " lake and river	121.040	71.2	
Total	170.099	100.0	

Suez Canal.

Canal in Excavation	87.2	87.9
Free Navigation, lake	12.0	12.1
Total	99.2	100.0

The Panama canal is wholly in excavation, 4.3 miles of it being below sea level, and 42.2 miles above sea level, and mostly very much above it, as will be seen by referring to our profile of that canal published June 2, 1889. Up to that date the company's estimates showed 49,000,000 cu. metres (65,000,000 cu. yds.) while there was about as much more work required even to make the lock canal. How many times more than this would have been needed to make a sea-level canal we can only guess. As this project is now hopelessly dead, however, we need not trouble ourselves further with data regarding it. The total estimate of rock and earth excavation for the Nicaragua canal is only 55,513,638 cu. yds. as shown in more detail below.

A previous more detailed summary, differing somewhat decimally with that just given, but so slightly that it does not seem worth while to take the trouble to correct the trifling differences, shows the canal to consist of the following elements:

		West Side. Miles	East Side. Miles	Total. Miles
A.	Sea level canal dredged in earth from the coast	.57	10.00	10.57
B.	Rock thorough cuts with or without a coating of earth on top	6.40	2.836	9.236
C.	Canal in earth, through cuts, no rock	2.42	2.146	4.566
D.	Canal chiefly in earth, but with a layer of rock in the bottom	2.00	.354	2.354
	Total canal, apart from locks	11.39	15.336	26.726
E.	Natural surface flooded by proposed water levels so as to give 30 ft. of water or over, without any dredging or excavation	4.53	13.60	18.13
F.	Do, requiring earth dredging only	.74	2.70	3.44
G.	Do, requiring rock excavation	0	0	0
H.	Locks	.369 All r'k	Rock .246 Earth .123	.738
I.	Natural water courses having 30 ft. or over on proposed level	37.04	43.67	80.71
K.	Do, requiring earth dredging only	2.40	24.67	26.50
L.	Do, requiring any rock excavation	3.5	10.33	13.83

SUMMARY.

		Miles
Natural water courses or artificial basins requiring no work at all on them to give 30 ft. of water		98.84
Basin, river, and lake navigation requiring earth dredging below proposed water surface only to give 30 ft. of water		39.94
Do, having a layer of rock in the bottom to be excavated or dredged		13.83
Canal sections, dredged in at sea level	10.57	
Earth thorough cuts, no rock	4.566	
Rock thorough cuts, some earth	9.236	
Earth thorough cuts, some rock	2.354	
Total length of canal in thorough cut		26.726
6 locks		0.738
		170.074

The company, somewhat to our regret, but we cannot say unwisely, prefer not to put forward at this time any estimate of total cost whatever. The quantities, as computed by their engineers, they are quite willing to give, and they are given below. The transverse and longitudinal sections on which the quantities are based are shown herewith, and if they do not suit any one's ideas of what such sections should be, it is easy to recompute the quantities from the data given in this issue, either precisely or approximately. As to the cost of the work per yard, there has been so much discredit, just and unjust, thrown on such estimates in the past, that the company as yet prefer to maintain an entirely non-committal attitude, and they decline to furnish us with any estimate on their part of what the work will cost per yard or in the aggregate, at least until the work has been actually let. They say simply: "Here are our quantities; here are the profiles and cross-sections on which the quantities are based; the climatic and other conditions, so far as known, are thus and so. Make your own estimates for the present of what the total cost will be." This privilege we exercise elsewhere to some extent, but in the meantime will merely note that Chief Engineer MENOCAL'S prices for the more important items in his estimate of 1885, which he states he has seen no reason to regard as too low, are as follows;

Earth excavation, per cu. yd	40 cts.
Earth dredging "	20 cts.
Rock excavation "	$ 1.50
Rock under water "	5.00
Stone pitching, rock furnished, per cu. yd	2.00
Concrete, per cu. yd	6.00
Stone in breakwaters (from divide cuts) per cu. yd	1.50
Sheet piling in place, per M. B. M	70.00
Trestles for dumping rock, per lin. ft	22.00
Clearing and grubbing, per acre	100 00

This includes the main items of cost. The total quantities for the larger items are:

		cu. yds.
Earth dredging for canal (all below sea level)		23,489,478
Earth excavation (all earth above sea level		16,440,368
Rock excavation		15,008,347
Do. under water		575,445
Total apart from harbor work		55,513,638
Greytown harbor, dredging	9,055,460	
Brito " "	5,658,898	14,714,358
Total earth and rock excavation		70,227,996
Rock fills for dams and breakwaters (from divide cuts)		4,845,787
Earth fills do. (borrowed or from canal excavation)		5,085,171
Concrete (chiefly for locks)		518,675
Stone pitching		94,813

Among the miscellaneous items provided for in the estimates whose adequacy can be most satisfactorily judged by their aggregate cost are the following:

Gates for the six locks	$783,242
2 movable dams or guard-gates	600,000
Machinery for locks	550,000
Buildings for locks	165,000
Pumping (chiefly for Locks 1 and 6)	200,000
Plant for lighting and buoying canal	372,200
Crib piers at entrances to canal (apart from breakwaters included in rock fills)	783,924
3 swing bridges across canal	60,000
128 miles telegraph	64,000
Total of miscellaneous items	$3,578,366

By adding the total of the above list to the product of the above list of prices any one can determine for himself what may be called the "visible cost," and he will find it in the neighborhood of $55,000,000. To this there must beyond all question be added a very considerable percentage for hospitals, shops, cost of labor supply, delays by possible epidemics. Even in this country we should add as a matter of course 10 per cent. to the above estimate for "engineering and contingencies." For this work there ought to be beyond all question a considerably larger percentage added, and there may be some question likewise as to whether there may not be slips and landslides, etc., which will require an enlargement of the proposed cross-sections. As to that, however, we may say that there seems little chance of it in the two big rock cuts where alone it could become an important consideration.

We ought to know absolutely as to this in a short time, when the borings through the rock are completed, as above noted, but in the meantime all the indications are that the rock will hold a steep slope well. This we understand to be the general opinion of all engineers and contractors who have examined the cut. Whatever other difficulties may arise, there seems no reasonable chance of there being another case of a mountain sliding in as fast as excavated, the formation being quite different from that at Panama.

The general character of the alignment of the whole route is correctly indicated in

Figs. 2 and 3. About two-thirds of the route is tangent (omitting the lake, which is all tangent) and the remainder easy curves of 4,000 to 6,000 ft., radius for the most part. The sharpest curve is in the divide cut, 2° 16', or 2,528 ft., radius. There are two or three other curves of about the same radius in the river, but for the most part the river channel is wide and straight. The precise alignment of the sailing line is not yet regarded as absolutely fixed; therefore, we do not give a complete table of alignment. A new alignment has recently been shown to be possible for the great divide cut, shown by the dotted line *A* in Fig. 3, which not only saves distance and curvature but saves about 1,000,000 cu. yds. of rock excavation included in the above quantities.

After the completion of the chief engineer's report and estimate, an Advisory Board to report on the practicability and cost of the canal, as proposed by the chief engineer, was appointed as noted in our issue of Jan. 26, the Board consisting of JOHN BOGART, E. D. T. MYERS, C. T. HARVEY, H. A. HITCHCOCK and A. M. WELLINGTON. This Board reported some time ago, but the company is not yet ready to give out the text of their report for publication for the reason above noted, that they do not desire as yet to commit themselves even by implication to any estimate of cost whatever, confining themselves simply to presentation of quantities, and other controlling conditions.

As for the two important and in a measure controlling conditions of climate and labor supply, we understand that the latter is not likely to be a very serious difficulty. Owing to the nature of the work, as above and below outlined, the number of employés required will not be at all in proportion to the magnitude of the work, since a very large part of it will be executed by machinery. All the earth excavation may be classed as dredging, since it will all be executed by dredging machinery, and this accounts for nearly 55,000,000 out of the 70,000,000 cu. yds. of excavation. For this, very few men will be required. The 500,000 yds. of concrete will also be mixed by machinery and require labor in any amount for ramming only. The 15,600,000 cu. yds. of rock is, most of it (14,000,000 cu. yds.), in the two great divide cuts, and will be drilled and hauled by machinery, requiring labor in large amount for loading only. Here, however, will be the greatest demand for labor, and possibly 10,000 men may be required on these two cuts alone. The dams and embankments are now to be all rock fills, and not built of concrete, as heretofore proposed, the suggestions of this journal in favor of so constructing the dams, made in its issue of July 28, 1888, having been adopted by the company, thus greatly simplifying that important part of the work. All the skilled labor which will now be required for the dams will be only for a little sheet piling and trestle work.

It appears to be generally admitted that Jamaica negroes will furnish the bulk of the labor, and that 10,000 to 15,000 can be readily obtained from that island alone at $1 per day, more or less. With the miscellaneous thousands who are quite sure to flock to the work from all the other surrounding countries and islands, this ought to make the question of labor supply a comparatively simple one; provided no long continued epidemics occur to drive away labor.

In respect to that question of health and climate, all accounts concur that the entire route is now and always has been free from dangerous epidemic diseases, and from frequent epidemics as well. Like New York and New Orleans, Greytown has had epidemics of cholera and yellow fever, but the last was some twenty years or more ago. In regard to the western coast, on which over a third of the work is situated, there does not seem to be the slightest ground for any anxiety as to health conditions. The climate is warm throughout the year, and hence somewhat debilitating for whites, but the rainfall is moderate, and there is rather less cause for anxiety than there would be for summer work in Texas, a great ameliorating influence being the brisk trade winds, which blow uniformly from the east over the entire length of the canal, and make the nights cool and comfortable. The importance of this advantage over Panama, where this trade wind is wholly absent, can hardly be exaggerated.

On the eastern division there is a great deal of rain; about as much as at Panama, or a decided

Fig. 3. Canal and Basin Part of Eastern Division, San Juan River to Atlantic Ocean. NICARAGUA SHIP CANAL, A. G. MENOCAL, *Chief Engineer.*

wetness throughout most of the year. There is also not a little *calentura* (the Spanish name for intermittent fever) which in tropical regions is at times a serious and fatal disease. But with proper care and caution, and avoidance of all use of stimulants except a small dose at night after work, there does not seem to be any difficulty in keeping in good health continuously in eastern Nicaragua. According to a great variety of independent information which has come to us from time to time, the great

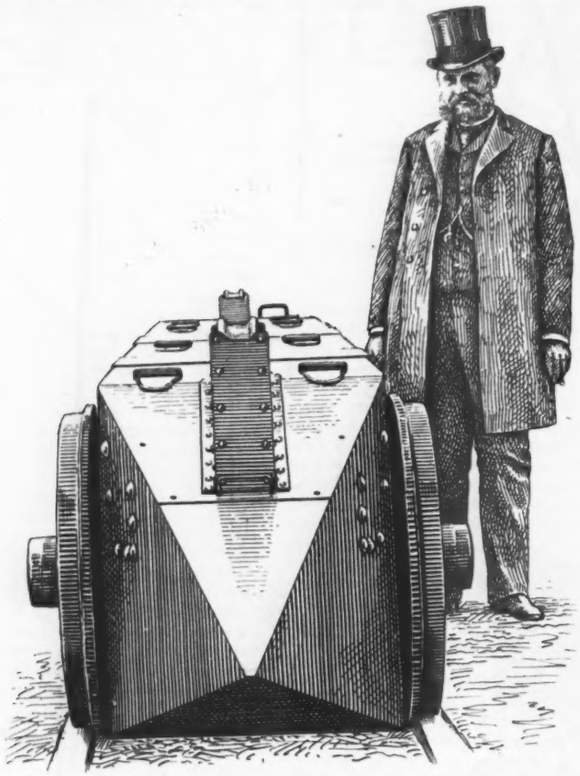

Fig 1. A Train on the Weems Electric Railway.

and only essential for health along the coast is strict attention to hygiene. Yellow fever has never existed continuously in Greytown, as it does in Havana and Vera Cruz. It may possibly become endemic during construction unless careful sanitary precautions are taken, because the town will be likely to have a mushroom growth to a considerable size; but the company, with eminent foresight and wisdom, are now laying pipes to supply abundant pure water, and purpose sewering the town also, we are informed, as soon as its growth begins.

A most important consideration in respect to this question, moreover, is this: The general character of the coast is a broad, low coast flat, through which the dredging occurs, ending in an abrupt escarpment, in the lowest point of which the "great divide cut" occurs, the main crest in the vicinity being upwards of 500 ft. high, and directly exposed to the trade winds. It is at this cut that the bulk of the laboring force is required. As the work will last four or five years at least, the camp may be permanent, and the conditions for insuring health in a great permanent camp exposed to the direct blast of the trade wind and with an abundant supply of pure, cold water, would seem to be unusually favorable. That they are so, and that health might be maintained in such a camp, by strict policing, even if epidemics were raging in Greytown, seems to be the general opinion of those who ought to know. There is no use disguising the fact, however, that there will be danger of sickness at Greytown, when the inevitable host of camp followers occupies it, unless, as ought to be done, the whole town can be put and kept under martial law.

It is proposed to construct 35 miles of railway on the eastern division, from Greytown to the Ochoa dam, and 18 miles on the western division, from the Pacific to the Lake. It is now under consideration, however, whether the 10 miles of railway between Greytown and Lock No. 1 cannot be saved, starting the railway from the latter point, and using east of it the natural chain of water communication shown on Fig. 3, improved a little at points, until a channel can be excavated through to the same point by the first cut of the dredges. In that case, the breakwaters at Greytown would be built by deposit of stone from scows instead of from railway cars. We cannot see why the suggestion is not a good one.

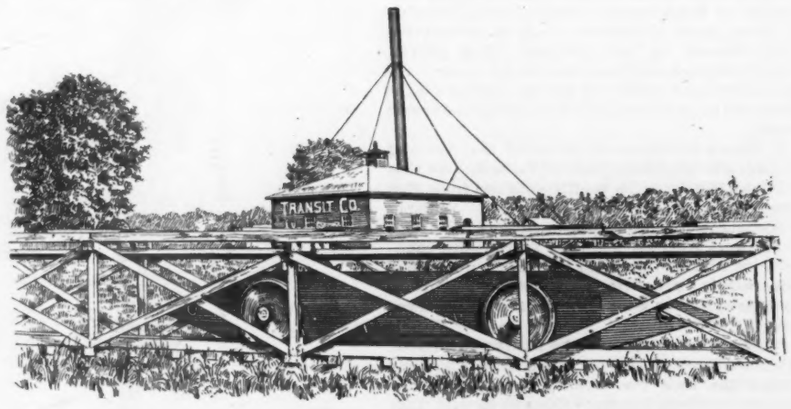

Fig. 2. The Weems Electric Railway; Side View of Motor.

The dimensions proposed for the locks are 650 ft. long by 70 ft. wide (increased this year from 65 ft.) by 28 ft. deep. The chamber width of the locks will be 80 ft. The Sault Ste. Marie lock, the largest yet built in the world, is 515 ft. x 80 ft. x 17 ft. on mitre sills, or 16 ft. draft. The new lock now building will be 800 ft. x 100 ft. x 21 ft., on mitre sills, but this great size is only for the purpose of letting through several vessels at once. The main dimensions of the largest ocean steamers are as follows:

	Etruria (and *Umbria*)	*City of New York* (and *City of Paris*)	*Teutonic* (and *Majestic*)
Length	501.6	565	582
Breadth	57.2	63.2	57.5
Depth hold	38.2	42.	39.2
Draft (about)	27	27+	27+

The above draft is about all these vessels can draw to enter New York; the "Plimpsol mark" is somewhat higher.

The above seems all the data which it is necessary to give, in addition to that given in our issue of July 14, 1888, and on another page of this issue. This is certainly the most important engineering project now before the world, and we cannot doubt will be triumphantly carried through to completion. Had the project in its present shape been before the Lesseps congress of 1879, it cannot reasonably be doubted that even that most prejudiced body would have adopted it *nem. con.*, as it is from every point of view so vastly superior to that at Panama; and the Nicaragua canal would now be open to the world, but, unfortunately, there was only the old survey of 1872-3, with its 20 locks, 4 dams of the San Juan, 6½ miles of extra distance, and 49 instead of 27 miles of canal excavation to lay before that body.

Preliminary work has been now for some weeks in progress on the canal, mainly in the way of getting the camps established; water pipes to supply Greytown laid; railway located and right of way cleared; deep drillings made through the rock cut; harbor works at Greytown started, etc., etc. No contracts have as yet been let, but negotiations are in progress with several parties. When the contracts are let they will probably be very large ones, to three or four parties only. We understand that the question of raising the money is now regarded as merely one of detail, not of difficulty.

The Weems Electric Railway.

This company, whose tests on their Baltimore track, we noted in our issue of Aug. 31, and which proposes to construct a second and longer 5-mile track at Garden City, was organized Feb. 13, 1888. The experimental track is at Laurel Station, on the Washington branch, Baltimore & Ohio R. R., about midway between Baltimore and Washington. It is precisely a 2-mile circle, constructed with only 16-lb. rails, and with rather rough surface and broken grades. The track is of 24-in. gauge. The motor is 18 ft. long by, say, 2⅓ × 2½ ft. cross-section, or 6.25 sq. ft., pointed in front. Two cars follow it, closely telescoped together, the rear car of the train being also pointed to diminish suction, so that the train is practically one snake-like body, pointed at head and front. The experimental train complete weighs about 6,000 lbs.; and this train, there appears to be no room for doubt, has been repeatedly driven around the 2-mile circle in somewhat less than a minute, affording some basis for the hope and belief expressed, that with better track and more complete appliances, speeds of 150 miles per hour may be attained. The projectors even talk of running "mail trains" at the rate of 4 or 5 miles per minute, or at the rate of only 228 to 182 minutes (3 to 3.8 hours), between Chicago and New York.

To see how reasonable such expectation is, we may start from the reported fact that they have actually made 2 miles per minute on their experimental track. The dynamo used is of 60 H. P., and was pushed to its full capacity. Then

$$\frac{60\ H.\ P. \times 60\ min. \times 33{,}000\ ft.\ lbs.}{5{,}280\ ft. \times 120\ miles\ per\ h.} = 187\tfrac{1}{2}\ lbs.$$

which is the average frictional resistance of the train under these stated conditions. This amounts to 62½ lbs. per ton of total resistance; or, if we consider a third of the resistance only to have been true frictional resistance, or 21 lbs. per ton, we have left 125 lbs. as the air resistance, which amounts to precisely 20 lbs. per ton per sq. ft. of sectional area. By Smeaton's scale, the best we have, this would correspond to the pressure from a wind of some 62 miles per hour only; but Smeaton's scale not being wholly reliable, and the apparatus being pointed at each end to reduce air resistance, this corresponds sufficiently well with the alleged facts for the latter not to seem incredible.

We were somewhat surprised at these results, not expecting them to correspond so closely with what theory would indicate, but they evidently do that fairly well. At present the principal practical use contemplated is the handling of mail and express matter, to which accidents due to the very high speed will be of minor moment. It is also expected, however, to extend the principle to passenger transport, after its use for freight has been made successful. A rail with a wide exterior flange is used, under which a catch rides so as to prevent derailment.

The adhesion is increased several fold by the electric current, otherwise there would not be enough for such rapid motion. The train is entirely controlled from the dynamo station, and there are no runners on board of it. Stopping is effected as follows: There are brakes actuated by powerful springs which normally press against the wheels. When the current is turned on, it acts through a coil on an armature attached to a toggle joint arrangement, in the usual manner, so that the brakes are held off so long as the current continues. Should there be any interruption in the track or conductor, as for instance, an open drawbridge, the current instantly stops and the brakes go on. The current can if desired be reversed, and the train then run backwards, so that it can be brought back from any moment to the starting point.

Using large copper conductors, it is expected that a single dynamo station can operate 40 to 50 miles each way, so that but one would be essential between Philadelphia and New York for example. It is not proposed to have more than one train on the same "block" at once. An automatic register is used, showing the position of the train. The center of gravity of the train is below the axles.

We give herewith illustrations of the motor and train from photographs taken at the company's experimental track at Laurel. Fig. 1 shows an end view of the train on the siding with the company's shops in the background. The pointed nose of the motor is about the only feature of interest which this view shows. We must confess to a most thorough inexperience in the design of the prows of locomotives intended to cleave the air at the rate of two or three hundred miles per hour; but it certainly seems that an alteration in the design of the "beak" of this machine would make a large difference in air resistance. As now designed, it seems as if the air sliding past the side planes would be held by the front wheels. It would seem better to have the sides straight, and let the machine cleave the air with a horizontal edge instead of a point. Wheel covers, which the air could pass smoothly over, would also tend to diminish the air friction.

This illustration also gives a very fair picture of Mr. DAVID G. WEEMS, the inventor of this new system of transit and the general manager of the company which is now perfecting it for practical use.

Fig. 2 is a side view of the motor, and shows also the manner in which the track is fenced, a very necessary precaution. It would probably be found advisable to add also a few strands of barbed wire to save the lives of dogs, pigs, lambs, and such small game, as well as those of the intoxicated gentlemen whose penchant for the railway track as a sleeping place is well known.

It would also be necessary to enclose sections entirely wherever snow was likely to drift upon the line, since a train of this weight, bolting along at a few hundred miles an hour, would be likely to be transformed into a rocket if it struck a fair-sized snow drift.

We have not deemed it necessary at this stage in the developement of this new transit scheme to present any detailed illustration of the mechanism of the motor and cars. The general form of the motor is shown in our engravings. The dynamo which drives it receives the current from an overhead conductor.

"THE SMOKY CITY," a title which Pittsburg resigned when she adopted natural gas, seems now properly to belong to Chicago. The rapid growth of manufactories in and all about the city, most of which use soft coal for fuel, has created the conditions which existed in Pittsburg years ago. The Citizens' Association is now agitating the matter of smoke prevention, and it bids fair to become as important a subject there as it has been abroad. Alderman DUNHAM intends to introduce an ordinance making the use of hard coal or coke obligatory upon tugboats, steamboats, and railway locomotives running within the city limits. Stationary furnaces working under natural draught will be allowed to use soft coal only when it is burned in a smokeless furnace. The Chicago *Tribune* warns the people of the city that unless they will take hold and abate the smoke nuisance, there will be no use trying to obtain the 1892 exposition for the city.

THE CAIRO BRIDGE is rapidly approaching completion, the last piece of steel having been placed Aug. 28. The bridge consists of three deck spans 249 ft. each, two through spans 518½ ft. each, and seven spans 400 ft. each; in all 12 spans, making a total length of 4,683 ft., exclusive of approaches. About two months more of work on riveting remain to be done. The date of completion is Dec. 31. The Union Bridge Company had the contract.

THE SILICA PROCESS for treating cast-iron is now in use at the foundry of the Pullman Car Co., at Pullman, Ill. The process is the invention of GEO. G. MULLINS, U. S. A. The introduction of silica is claimed to make the melted metal more fluid, while the castings have a greater resistance and ultimate tensile strength, the latter averaging in tests about 15 per cent. above that of untreated iron. It is also possible by the process to make use of scrap and lower grades of pig than could be used formerly for first-class castings. The cost of the treatment is but a few cents per ton. The Pullman foundry has an average output of 2,000 tons per month.

It is reported that the demand for the Westinghouse automatic compound engine is such that engines are contracted for before their building has been even commenced. Until recently only seven sizes were built, from 25 to 150 H. P. It was found necessary to add two more sizes of 200 and 250 H. P. and every effort is being made to finish them, as twelve of the former and several of the latter have already been sold

PERSONAL.

Mr. W. P. MOORE has been appointed Contracting Agent for the Rome, Watertown & Ogdensburg.

Mr. J. J. MAHER, Contracting Agent of the Erie, at Cincinnati, died recently.

Mr. J. M. PHILLIPS has resigned his position as Division Superintendent of the northern division of the Gulf, Colorado & Santa Fé.

Mr. J. BRADT, for 30 years Master Mechanic on the Erie road, has resigned, and is succeeded by Mr. J. E. SAGUE, of the Erie shops at Jersey City.

Mr. J. MCDONNELL has been appointed Roadmaster of the Nickel Plate, vice Mr. EDWARD MURPHY, who died recently at Valparaiso, Ind.

Mr. BAERMANN, the newly appointed City Engineer of Troy, N. Y., has resigned his position as Superintendent of the Troy Water-Works.

Mr. WILLIAM PURCELL, of Sing Sing, and Mr. C. B. LENT, of Yorktown, have been appointed Division Superintendents on the old Croton aqueduct, for Sections 1 and 2, from Croton Dam to Tarrytown.

Mr. ROBERT BELL, Division Superintendent of the Western New York & Pennsylvania road, has been appointed General Superintendent, vice Mr. G. S. GATCHELL, resigned.

Mr. W. W. HEGEMANN, who has for some years been connected with the Baldwin Locomotive Works, has been appointed to succeed Col. JAMES MONTGOMERY as Superintendent of the Ohio Valley Ry.

Mr. A. C. ARMSTRONG, purchasing agent of the Atchison, Topeka & Santa Fé Ry., has resigned. His successor will be Mr. WILLIAM G. FULLER, formerly of the Erie road.

Mr. M. A. ZOOK, Engineer of Maintenance of Way on the second and fourth divisions of the Pennsylvania lines west of Pittsburg, has resigned on account of ill health, and has been succeeded by Mr. W. S. NEWHALL.

Mr. E. T. JEFFREY, General Manager of the Illinois Central, has resigned, after having been for 30 years with the road. Mr. C. A. BECK, second Vice-President, will succeed him temporarily.

Mr. E. C. WINSTANLEY, General Manager of the Zanesville & Ohio River Railway Co., has been elected President and General Manager of the Shawnee & Muskingum River Ry. Co., with headquarters at Zanesville, O.

We regret to note the death of Major ROGER P. ATKINSON, of Greensboro, N. C. Mr. ATKINSON has for three years past held the post of Chief Engineer for the Cape Fear & Yadkin Valley Ry. Co., and had performed well his onerous duties in connection with the various extensions which the company has pushed forward.

Mr. D. H. CONKLIN has retired from his position as General Manager, Vice-President, and Treasurer of the Terre Haute & Peoria Ry. President C. W. FAIRBANKS, of Indianapolis, appointed J. W. BURGEON, late of Fremont, O., to be Treasurer and General Manager. Mr. BURGEON has held responsible positions under Mr. C. E. HENDERSON, General Manager of the O., I. & W. and the Ohio Southern.

Public Works Commissioner GILROY, of New York, has appointed the special staff which is to supervise the laying of the new street pavements, authorized under a recent act of the Legislature, for which an expenditure of $3,000,000 was provided: Assistant engineer C. H. BULL, salary, $2,500; transitman, T. S. OXHOLM, salary, $1,500; leveler, W. A. DAWSON, salary, $1,200; rodman, E. A. BYRNE, salary, $1,000.

PUBLICATIONS RECEIVED.

—*Monopolies and the People*, by CHARLES WHITING BAKER, C. E., Associate Editor of the ENGINEERING NEWS. 5¾ x 8 ins., 263 pages. Cloth bound. G. P. Putnam's Sons, "Questions of the Day" series. $1.25. For sale by Engineering News Publishing Co.

As the author of the above volume is a member of the editorial staff of this journal, no review or criticism of the work can be made in these columns. We make, however, some extracts from the author's discussion of the railway problem elsewhere in this issue, and to give our readers some idea of the general scope of the work present herewith an abridged Table of Contents:

Chapter I. The Problem Presented.—An impartial investigation by scientific methods necessary. II. Trusts and Monopolies in Manufacturing Industries.—Trusts at once a benefit and a curse. III. Monopolies of Mineral Wealth. IV. Monopolies of Transportation and Communication.—Intensity of competition.—Pools.—Evils charged to railway monopolies. V. Municipal Monopolies.—Street railways, gas and water supplies, electric service, railway terminals, etc. VI. Monopolies in Trade. VII. Monopolies Depending on the Government.—Copyrights, patents, the tariff. VIII. Monopolies in the Labor Market.—The C. B. & Q. strike.—Labor organizations. IX. Monopolies and Competition in other Industries. X. The Theory of Universal Competition.—"Competition the life of trade." XI. The Laws of Modern Competition.—The three salient causes of monopoly.—The proper remedy for monopoly. XII. The Evils due to Monopoly and Intense Competition' XIII. Ameliorating Influences. XIV. Remedies for the Evils of Monopoly.—Societism and individualism. XV. The Sovereign Rights of the People and their Representative, the Government. XVI. Practical Plans for the Control of Monopolies.—Railways, municipal monopolies, mineral monopolies, trusts, etc.

—*The City of Grand Rapids (Mich).* Manufacturing advantages, commercial importance, and sketches of the principal industries and business houses. ROB. H. BAKER, Editor; H. L. CRESWELL, Assoc. Editor. Published by B. F. Conrad & Co. 1889. Pamphlet, 166 pp., and table of contents.

—*How to Make the Desert Blossom as the Rose.* San Francisco *Daily Chronicle* of Aug. 23, 1889, 8 page supplement.

It is not often that a daily newspaper issue demands chronicle among our list of publications received, but this issue of the *Chronicle* demands it, since it contains a well-written and really valuable treatise on irrigation, divided into 18 chapters, and long enough in itself to make a respectable book—respectable in every sense.

—*Catalogue of the Berlin Iron Bridge Co.*, East Berlin, Conn. Oblong, 8 vo., pamph., pp. 127.

Besides bridges, this catalogue covers roofs, corrugated iron doors and shutters, iron floors, concrete bridges, and other like specialties.

ENGINEERING NEWS

AND

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CHAS. W. BAKER E. E. R. TRATMAN M. N. BAKER
ASSOCIATE EDITORS,
GEO. H. FROST . . . . . BUSINESS MANAGER

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Drawings for publication *should preferably be in plain black and white; considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

American Society of Civil Engineers.—Regular meeting, Sep. 18. Discussion of Mr. Cooper's paper on "American Railroad Bridges." John Bogart, 127 E. 23d St., New York City.

American Institute of Mining Engineers.—The 55th meeting will be held at Ottawa, Ont., beginning Oct. 1. Local Secy., B. T. A. Bell 14 Metcalf St., Ottawa. Secy., Prof. R. W. Raymond, 13 Burling Slip, New York City.

Boston Society of Civil Engineers.—Next meeting, at Mass. Inst. of Technology, Sept. 18. "Mills and Mill Construction," by Edward Sawyer. Secy., S. E. Tinkham, City Hall.

Engineers' Club of Kansas City, Mo.—Next meeting, Oct. 7. "Tests and Observations on Building Stones," J. A. L. Waddell and W. D. Jenkins. Secy., Kenneth Allen, 310 Baird Building.

American Forestry Congress.—Annual convention at Philadelphia, Pa., Oct. 15 to 18. Secy., J. W. Harrison, Franklin Falls, N. H.

In our issue of Sept. 28 we shall publish map No. 19 of our series, showing the railway construction in the Southwest, including Missouri, Kansas, Arkansas, Indian Territory, Texas, and Louisiana. The reports we have received from the railways in this section show considerable construction under way and projected, much more than was shown on our recent map of construction in the Northwest.

We take this opportunity to call the attention of those who wish these maps bound separately, to the second annual number of ENGINEERING NEWS Atlas of Railways, which will be issued early in 1890, and will contain the entire second series of maps of railway construction, the series of railway system maps, the last of which was published last week, and other insets which have appeared in this journal during the year. Each map will be accompanied by the articles having reference to it, as last year; but the much greater amount of matter will make the book more than double the size of the last issue. The price of the book will be $5.00 post-paid. Advance subscriptions may be sent in at any time. The Nicaragua Canal profile which appears in this issue will also be included in it.

It is proposed to celebrate at Springfield Mass., on Oct. 3, the fiftieth anniversary of the completion of the Boston & Western Railroad (now Boston & Albany) from Boston to Springfield. The road was an extension of the Boston & Worcester, and it was almost wholly due to the energy and public enterprise of Springfield in subscribing to the stock of the proposed road, that it was finally completed. The preliminary survey for the line was made by JOHN M. FESSENDEN. The most tireless worker for the project was GEO. BLISS, of Springfield. At the celebration of the final completion of the road to Springfield, the principal orator was EDWARD EVERETT, then the Whig candidate for governor.

It is more than likely, however, that the anniversary of this momentous event in the history of Springfield will pass without public recognition. The attitude of the public toward the railways has undergone a revolution in the half century since the era of railroad construction began, more marked in the West than in New England, indeed, but plainly apparent there. This condition of affairs is a deplorable one; for to have the public avowedly hostile to the industry of transportation, which has valid claims to public favor, and is wholly dependent upon it, is a dangerous state of affairs. The blame for its existence rests partly with each party, but principally with the changed conditions of the present day. Two men could not long do business with each other peaceably without some standard of values; and the public and the railways likewise cannot again enjoy the harmony of a half century ago until their relations to each other are definitely understood. It is most true that in very many ways the interests of the railways and their patrons are identical. But in so far as they are diverse, that diversity should be recognized and equitably adjusted upon some permanent basis.

The close of the first half century following the completion of this important line of railway, which the most public-spirited men of the last generation labored to construct, finds the great enterprise frowned on and mistrusted as if it were a public enemy. Certainly this anomalous state of affairs cannot long continue. It is to be sincerely hoped that, long before the next half century rolls round, the ill feeling which is now prevalent may give place to a more natural and healthy relation.

SINCE the above was in type we find in the Springfield *Republican* of Sept. 11 a letter from a Pittsfield manufacturer, who says, 'Let us have the celebration by all means, and let the orator tell us why the Boston & Albany charges $1.00 a ton freight on coal from East Albany to Pittsfield (50 miles) when the coal roads haul a ton from the mines to East Albany (530 miles) for $2.39.' He also suggests that a picture of abandoned iron-works in Taunton and other places be painted on the drop curtain and that the stage be ornamented by evergreens from the abandoned farms of Berkshire.

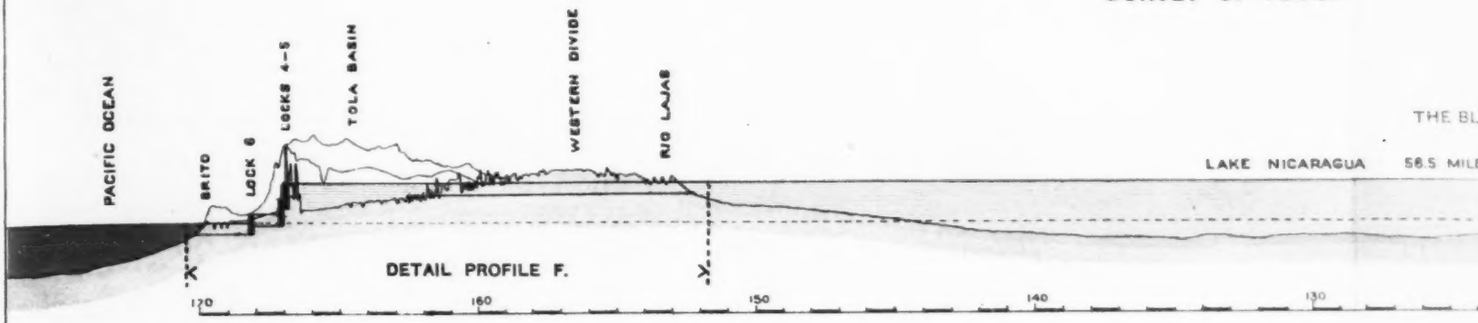
When sentiments of this sort are uppermost in the minds of railway patrons, a railway celebration would not be likely to be a mammoth success. Of course it is nonsense to blame the railways for the decline of iron-working in New England; but as long as people indulge the delusion that a railway can charge what it pleases for freight and live, such false impressions will be widely prevalent.

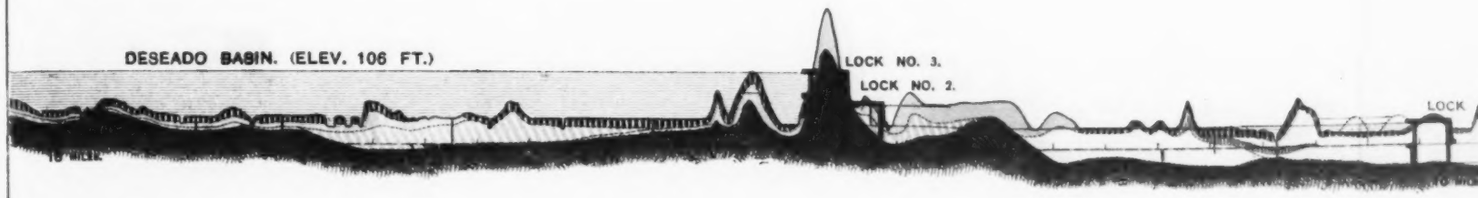
THE Massachusetts Institute of Technology now attempts to fit students for eleven instead of ten different kinds of professional career, having added a course in sanitary engineering, with the degree of "S. E.," we presume, as a climax thereto. The step itself is an eminently wise one, for there can be no doubt that the growth of cities and of luxury and population generally is making the study of sanitary science an increasingly important one, which ought also to offer an increasingly attractive professional career. But one cannot help thinking more than ever, on hearing of each new course, that our systems of instruction or of conferring degrees, or both, require some radical reconstruction. It is impossible for any one not extraordinarily gifted to absorb in four years' time much more than that general knowledge of many branches of science which ought to be common to all practitioners in any of the specialized branches of engineering. Keeping in view the well-known fact that many graduate "C. E.'s" do, in fact, become "M. E.'s," or *vice versa*, is it, in fact, either sensible or right to confer different degrees implying (or rather, asserting) that a man has the specialized knowledge required for the practice of some particular specialty for such slight differences of preliminary study as actually exist,—differences which hardly represent more than two or three months' steady work by the maturer mind? It appears to us clearly not; and we anticipate with confidence that, as we advance in civilization, no other degree than some general one, like "B. S.," will be conferred by respectable colleges as a result of the ordinary four-year course; and that some years of practical experience, with a year at least of post-graduate study, or its equivalent in an examination, will be required before the special degrees are granted.

WE know of no principle of ethics which makes a lie any more respectable for being solemnly engrossed on parchment, and certified to by a president and faculty; and the plain truth of the matter is that the certifying that boys who have been four years at school are "civil engineers," or "mechanical engineers," or "engineers of mines," or "sanitary engineers," is a lie out of the whole cloth, and known to be such by those who certify it. If so, it is a demoralizing and injurious practice which ought to be stopped. The excuse for it is, of course, that there is no actual deception; that it is well understood that the degree actually means no more than that its holder has given four years to studying the given profession, and that the same objections hold to the time-honored "M. D." for physicians. But this is hardly the case. The "M. D." degree means merely that a man is "learned," or "taught in medicine," and hence tells no palpable lie. Moreover, it has been reserved for this country to evolve the theory that even this title should be conferred indiscriminately on every youth who has studied medicine three or four years. The bulk of the medical practitioners of England have plain "Mr." as their only title, as should be the case in every civilized country, leaving the title "Dr." to be conferred on those who are really learned. But granting the degree to be a proper one for our miscalled "doctors," it does not follow that it is a proper one for any kind of engineering students. Engineering is a practical profession. The student cannot learn it by however long study at school, as he can astron-

NICARAGUA INTEROCEANIC

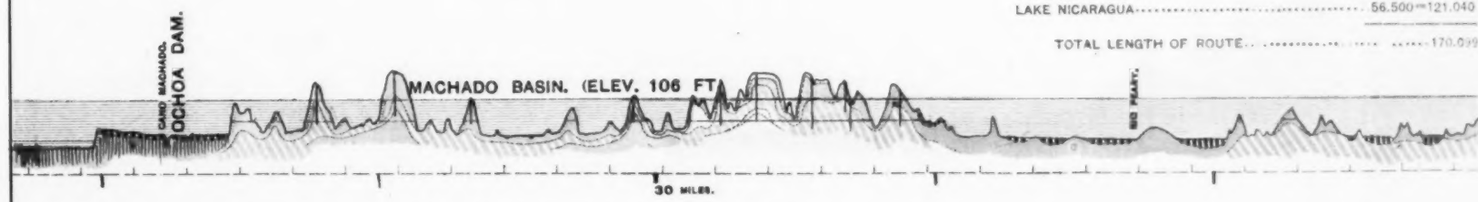
SURVEY OF 1888.

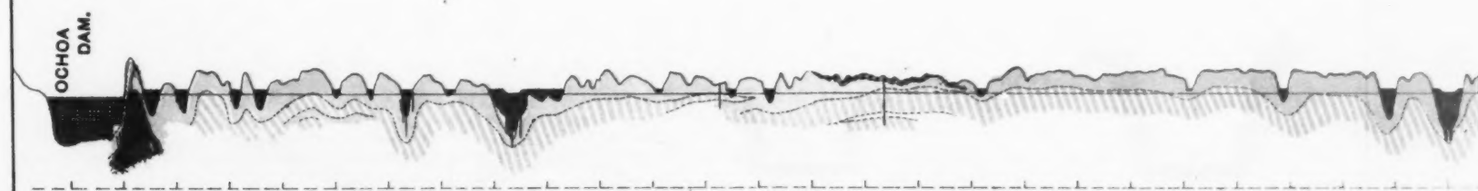


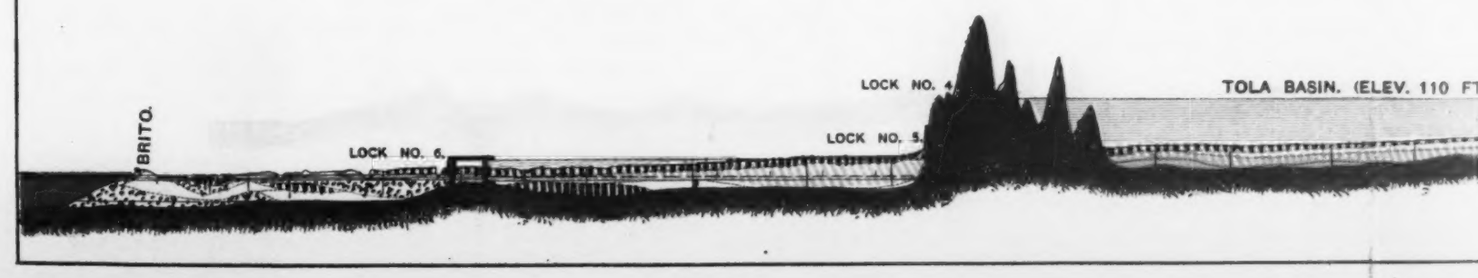


BORINGS. { THE POSITION AND DEPTH OF BORINGS TAKEN ALONG SAILING LINE ARE SHOWN TO SCALE BY VERTICAL BLACK LINES. VARIOUS BORINGS TAKEN ON EITHER SIDE OF SAILING LINE DO NOT APPEAR ON THESE PROFILES.

		MILES.
CANAL IN EXCAVATION—	EAST SIDE	16.048
" " "	WEST SIDE	11.160
" " "	SIX LOCKS	0.759 = 27.907
BASIN OF THE DESEADO		4.220
BASIN OF THE SAN FRANCISCO		11.368
BASIN OF TOLA		5.504 = 21.092
RIVER SAN JUAN		64.540
LAKE NICARAGUA		56.500 = 121.040
TOTAL LENGTH OF ROUTE		170.099







EANIC SHIP CANAL. GENERAL PROFILE, AND DETAIL PROFILES SHOV

PROFILES B, C, D AND F HAVE BEEN REDUCED PHOTOGRAPHICALLY FROM THE ORIGIN
HORIZONTAL SCALE OF 400 FEET TO 1 INCH, AND A VERTICAL SCALE OF

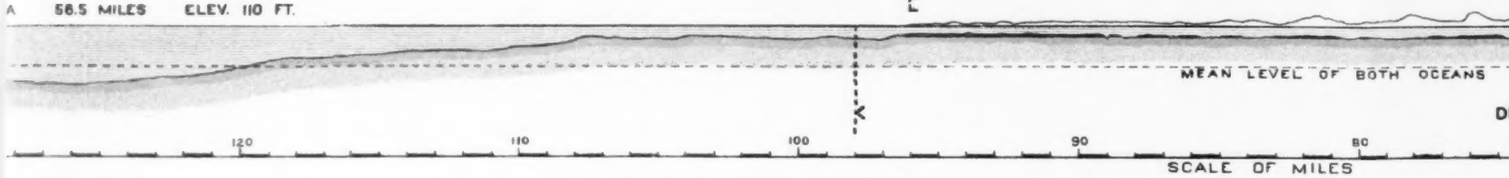
A. CONDENSED GENERAL PROF

THE BLUE AREA ON THIS PROFILE IS ALL FREE NAVIGATION IN BASINS, RIVER AND LAKE.

FT. SAN CARLOS

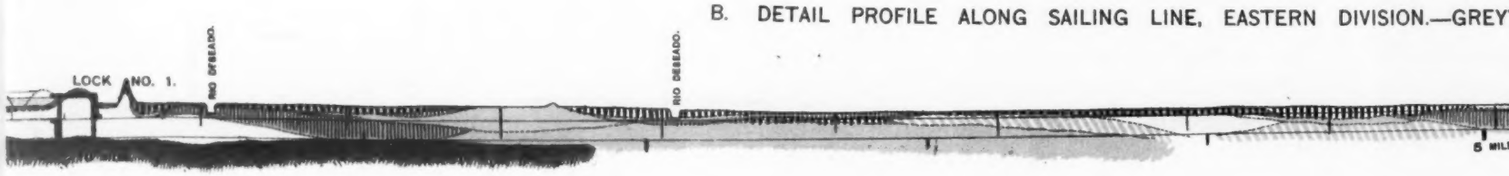
THE AREA COLORED ORANGE ALONG THE SAILING LINE IS THE

A 58.5 MILES ELEV. 110 FT.



B TO F. DETAIL PROFILES SHOWING CHARACT

B. DETAIL PROFILE ALONG SAILING LINE, EASTERN DIVISION.—GREY



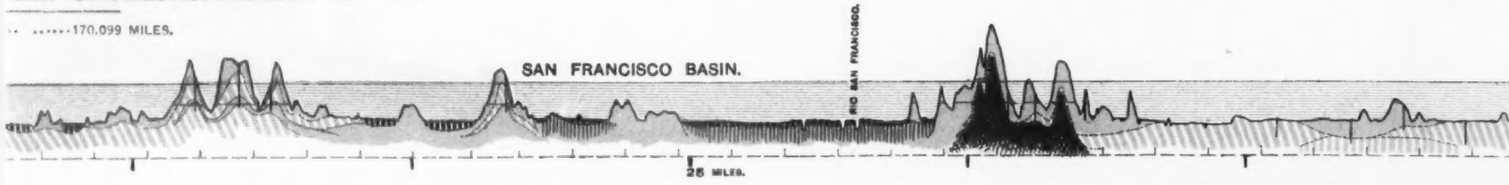
MILES.
·16.048
·11.160
· 0.759 = 27.907 MILES CANAL IN EXCAVATION.

· 4.220
·11.368
· 5.504 = 21.092 MILES FREE NAVIGATION IN BASINS.

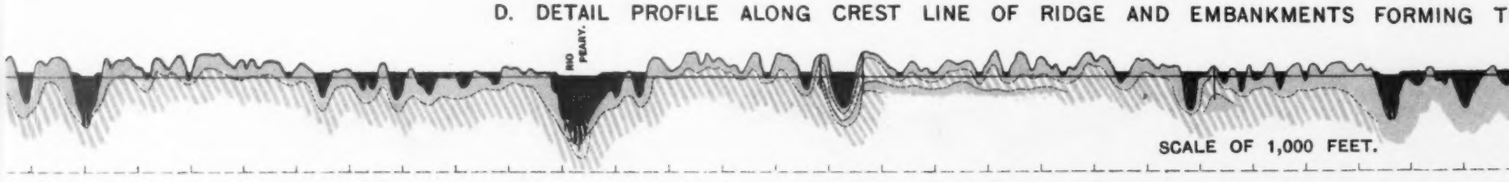
·64.540
56.500 = 121.040 MILES FREE NAVIGATION IN RIVER AND LAKE.

·· ·····170.099 MILES.

C. DETAIL PROFILE ALONG SAILING LINE, MIDDLE DIVISION.—DESEADO



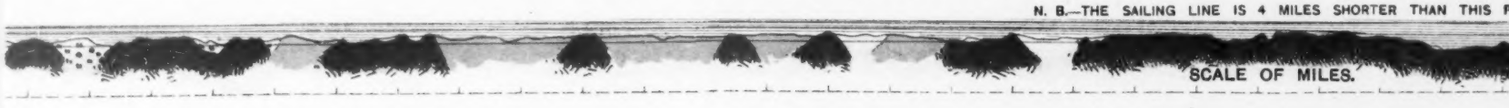
D. DETAIL PROFILE ALONG CREST LINE OF RIDGE AND EMBANKMENTS FORMING T



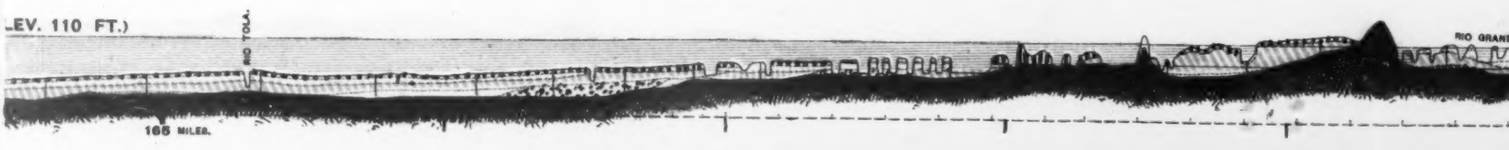
FALL FROM LAKE TO OCHOA 5/4 INCH PER MILE.

E. DETAIL PROFILE (TO REDUCED SCALE) ALONG CENTER LINE OF SAN JUAN

N. B.—THE SAILING LINE IS 4 MILES SHORTER THAN THIS P



F. DETAIL PROFILE ALONG SAILING LINE, WESTERN DIVISION.—LAKE



CHAS. HART & SONS. LITH. 36 VESEY ST. N. Y.

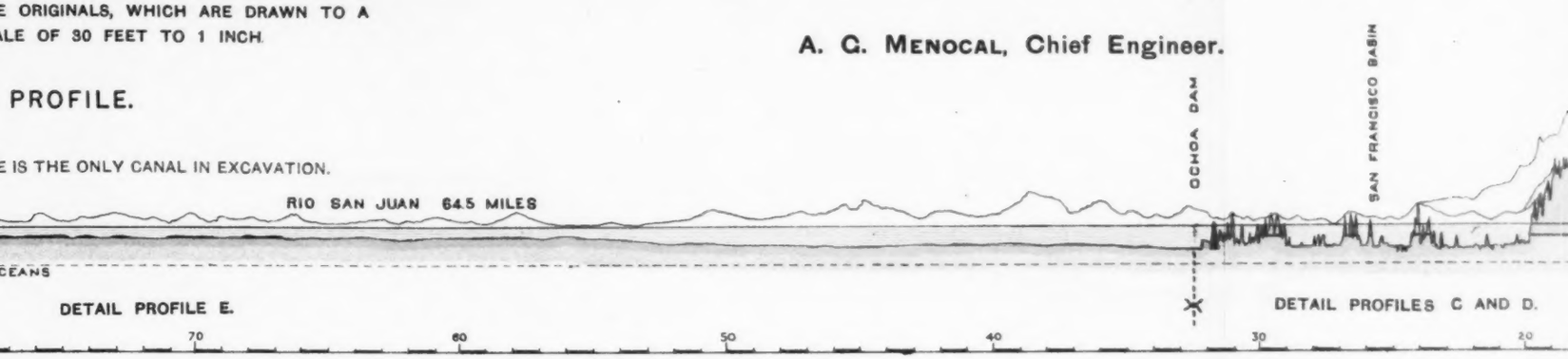
SHOWING CHARACTER OF MATERIAL AS DETERMINED BY BORINGS.

E ORIGINALS, WHICH ARE DRAWN TO A
ALE OF 30 FEET TO 1 INCH.

A. G. MENOCAL, Chief Engineer.

PROFILE.

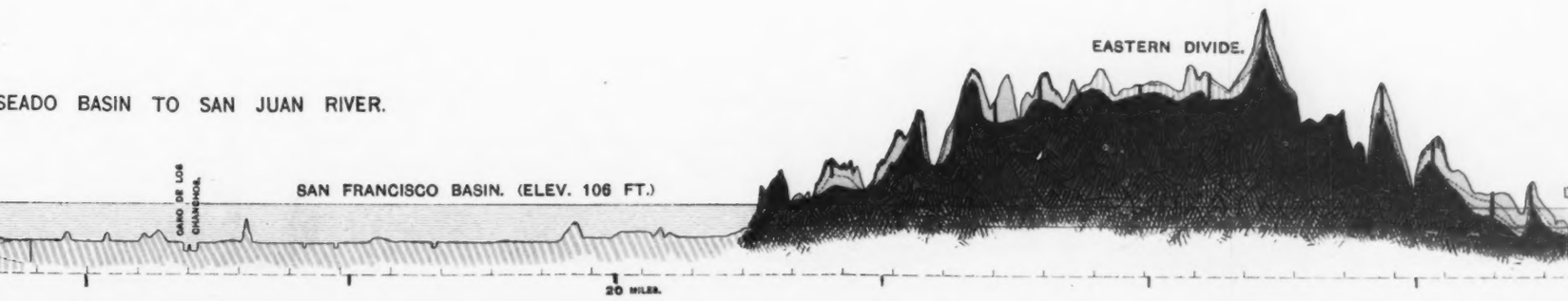
E IS THE ONLY CANAL IN EXCAVATION.



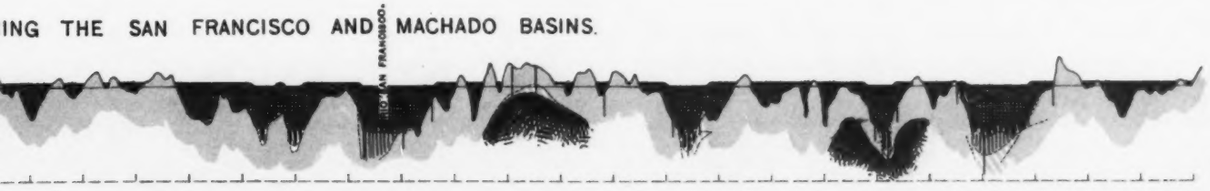
ARACTER OF MATERIAL.

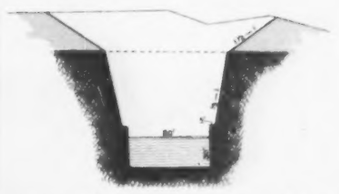
—GREYTOWN TO DESEADO BASIN.

SEADO BASIN TO SAN JUAN RIVER.



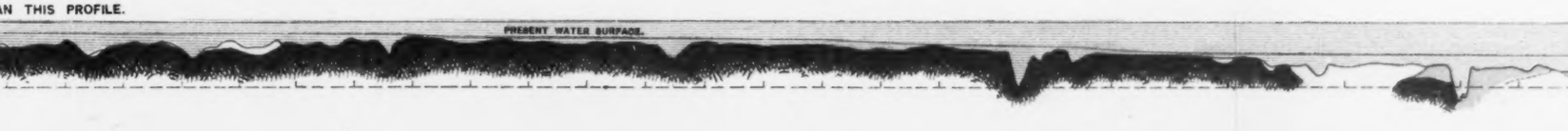
ING THE SAN FRANCISCO AND MACHADO BASINS.



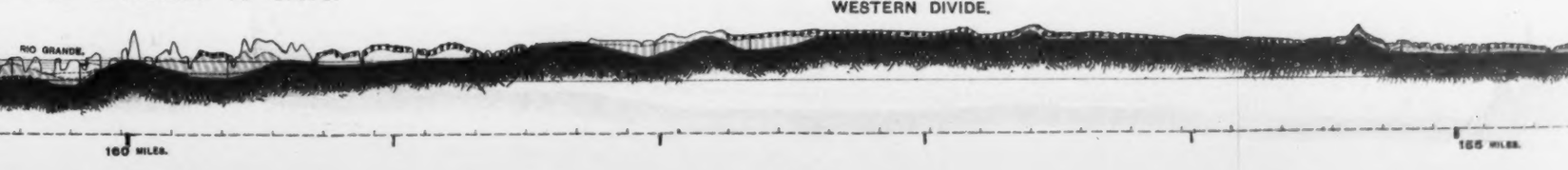


AVERAGE CROSS SECTION EASTERN DIVIDE.

JUAN RIVER— OCHOA TO LAKE NICARAGUA.
AN THIS PROFILE.



.—LAKE NICARAGUA TO BRITO.

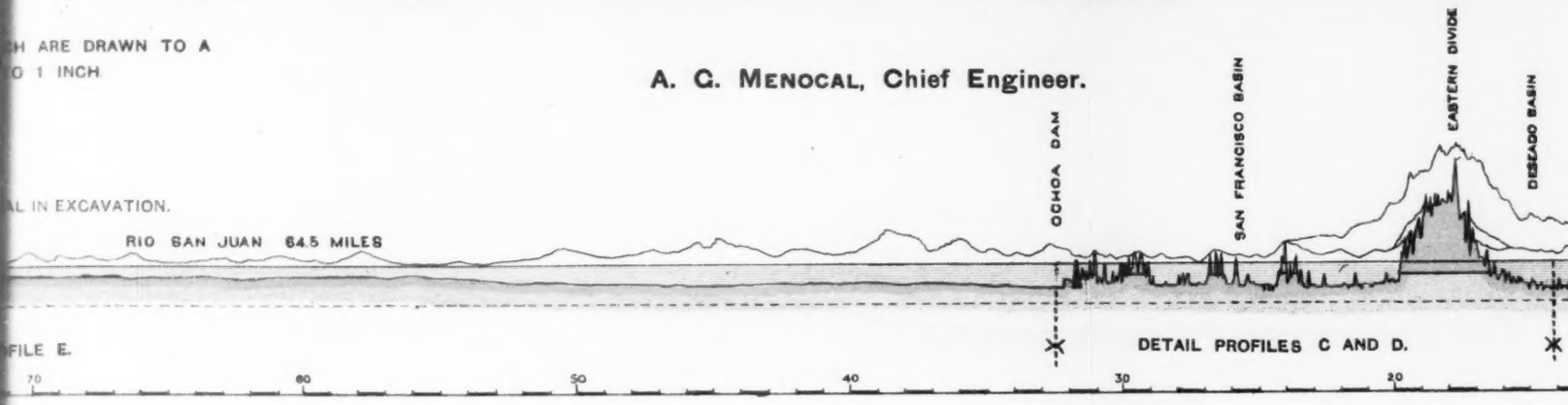


LN.Y.

CHARACTER OF MATERIAL AS DETERMINED BY BORINGS.

H ARE DRAWN TO A
O 1 INCH.

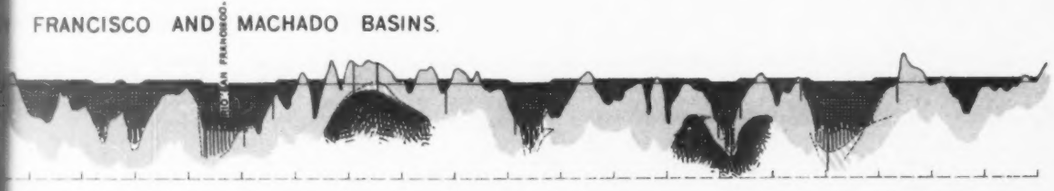
A. G. MENOCAL, Chief Engineer.

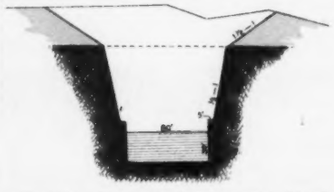


F MATERIAL.

O DESEADO BASIN.

FRANCISCO AND MACHADO BASINS.

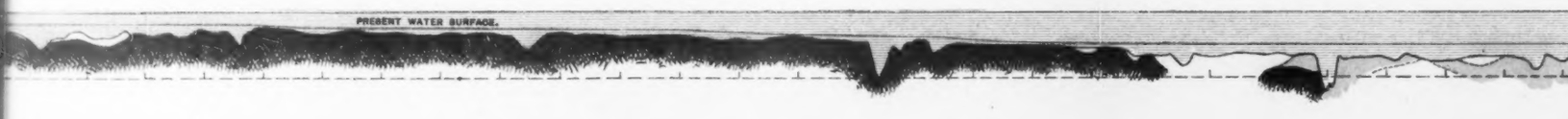




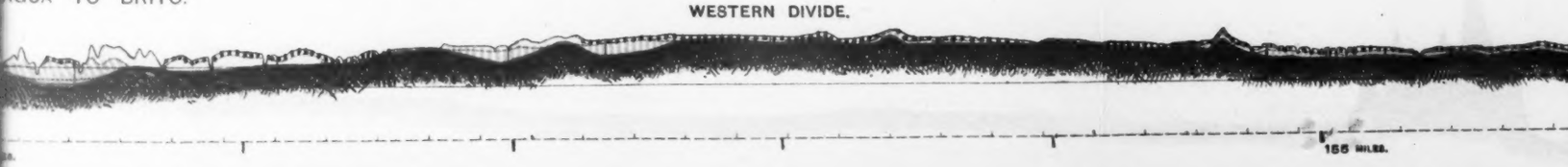
AVERAGE CROSS SECTION EASTERN DIVIDE.

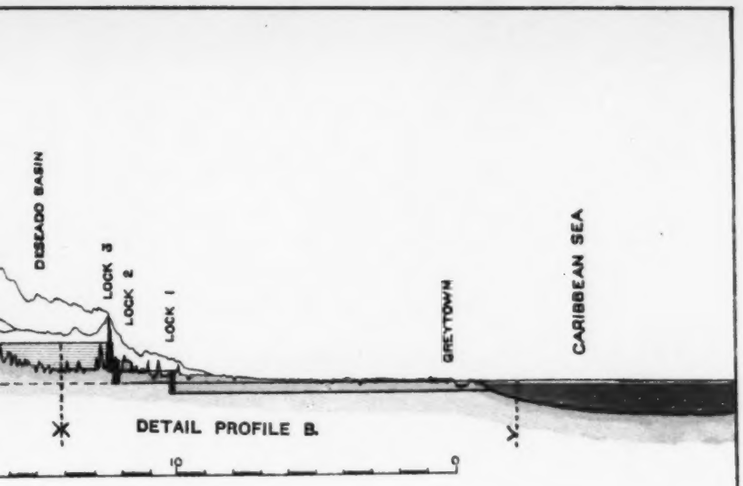
AVERAGE CR

OCHOA TO LAKE NICARAGUA.



AGUA TO BRITO.





DETAIL PROFILE B.

10 0

SYMBOLS FOR MATERIALS.

ROCK, ...

CLAYS, ... RED. BLUE. YELLOW. WHITE.

SANDS, ... YELLOW. BLACK.

CLAY AND SAND, ...

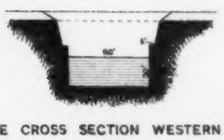
GRAVEL, ...

LOAMS, ... BLACK. CLAY. SAND.

WATER, ... SALT. FRESH.

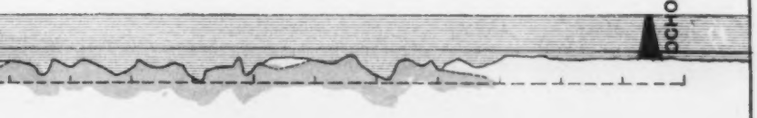
EMBANKMENTS, ...

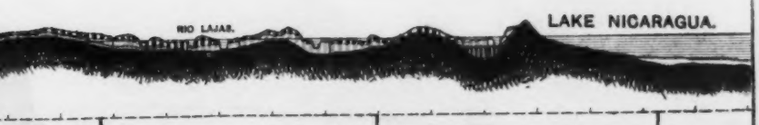
DO BASIN. (ELEV. 106 FT.)



ERAGE CROSS SECTION WESTERN DIVIDE.

AVERAGE CROSS SECTION IN EARTH.





omy, surveying, painting, chemistry, or (with sufficient hospital practice) medicine: he must have experience in the actual practice of his profession. Therefore the whole tribe of "C. E." degrees are intrinsically and especially improper, failing some years of practice. We hope in time we shall become civilized enough to abolish them.

The Nicaragua Canal Project.

It has been evident for some time to the careful observer that, although the day of small canals is over, the day of great ship canals is just dawning. Heretofore, although there has always been as great proportional need as now for ship canals to shorten sailing distances, yet the means for construction, both mechanical and financial, were so much more limited, and the aggregate volume of traffic to be accommodated so small, that there was not enough traffic "in sight" to pay interest on a cost necessarily far greater than it is to-day.

Accordingly, we find that, although ship canals at Suez, Panama, Nicaragua, Corinth, Cape Cod, and elsewhere have been talked about for centuries, yet it is only within the last three decades that the first of them, that at Suez, has really been completed and put to use. At the present moment there are a dozen or so of them in various parts of the world which either are or are likely soon to be under way, as we may show more fully before we close.

This is but the natural effect of the great change of conditions alluded to, and it is important to remember that the end is not yet in this change, great as it is. Capital is so cheap that interest is less than half what it was twenty years ago; engineering appliances are so improved that the cost in labor and time of executing great public works is certainly not more than half what it was twenty years ago; commerce has multiplied with even more marvellous rapidity. The railway mileage of the world has doubled since 1875, or in 14 years, and that of the United States has doubled since 1877. The shipping has multiplied in the still more marvellous ratio shown in the table below.

Shipping Tonnage of the World.

Thousands omitted.

	1820	1840	1860	1870	1881	1888
Sail	3,140	4,560	9,586	13,826	15,002	9,497
Steam	6	116	820	1,918	5,644	11,552
Total	3,146	4,676	10,406	15,576	20,646	21,049
do. effective	3,170	5,140	13,686	20,646	43,222	67,257
Equiv. p. c. per decade		27.3	63.2	50.9	95.8	88.1

[The "effective" tonnage is ascertained by multiplying the steam tonnage by 5, and adding the product to the sailing tonnage, steamers making about five times as many voyages per year as sailing vessels. The percentages in the last line gives, the correct *decennial* ratio, regardless of the actual period between the figures.]

It is but natural that great enterprises, which lagged along hopelessly in the '40's, '50's, and '60's, should now be begun with confidence, and it is quite certain that enterprises of any promise, which even now are neglected, will not be likely to be neglected long. For example, we can hardly expect the Nicaragua canal to be opened before 1895, or 7 years from 1888. In view of the above accelerating ratio up to 1888, what is the commerce of the world likely to have grown to when it is opened? Obviously it will be vastly larger than it is now, and that is enough for our present purpose; but we should bear in mind also that the commerce tributary to it is the most vigorously growing in the world. Perhaps, however, as giving a more direct indication of how traffic tends to multiply, we may as well give here the following table of the growth of traffic of the Suez and Sault Ste. Marie canals since they were opened to commerce, the enormous jump in the "Soo" traffic in the last year being especially notable.

Transit through Suez Canal.

Year	No. of vessels	Net tonnage.	Receipts from tolls.	Av. toll.
1870	486	436,609	$869,152	$1.99
1871	765	761,467	1,519,077	1.99
1872	1,082	1,160,743	2,875,418	2.47
1873	1,173	1,307,767	4,170,145	3.04
1874	1,264	1,631,650	4,533,558	2.77
1875	1,494	2,009,984	5,286,158	2.64
1876	1,457	2,006,771	5,326,292	2.63
1877	1,663	2,335,447	6,036,186	2.57
1878	1,593	2,260,678	5,669,194	2.49
1879	1,477	2,263,332	5,426,223	2.39
1880	2,026	3,057,421	7,298,524	2.43
1881	2,727	4,136,779	9,438,776	2.28
1882	3,198	5,074,808	11,086,208	2.18
1883	3,307	5,775,861	12,111,698	2.09
1884	3,284	5,871,500	11,725,752	2.00
1885	3,624	6,335,752	12,011,452	1.89
1886	3,100	5,767,655	10,954,215	1.89
1887	3,137	5,903,624	11,199,060	1.89
1888	3,440	6,640,854	12,007,524	1.89

[Receipts are computed at 5 francs per dollar. Net tonnage is about 70 per cent. of the gross tonnage.]

Transit through Sault Ste. Marie canal.

Year ending	Days open for navigation.	No. of vessels.	Net tonnage	Operating expenses.
1881	198	3,304	1,802,571	(Not at hand)
1882	229	4,676	2,379,210	$28,854
1883	216	4,163	2,130,181	35,510
1884	233	4,768	2,540,799	31,213
1885	219	5,629	2,981,786	27,242
1886	222	6,203	3,701,014	25,401
1887	218	7,926	4,882,802	22,130
1888	210	8,823	5,581,169	29,866
1889	——	8,832	6,932,203	——

[The first Sault canal was finished in 1855, at a cost of $999,802. The above statistics begin with the opening of the new canal.]

On the other hand, from the accompanying little diagram, which we reproduce from our issue of April 27, 1889, it will be seen that the greatest *small* canal in the world by far, in every sense, has been steadily falling off in traffic since 1873, and is now even smaller than it was in 1862, when it was larger than ever before. We need not seek far for a reason. It lies in the simple fact that the railways have distanced the small canals, not only in speed, but in actual cost of transportation, while they still lag far behind large ships and steamers in economy of transport, and to all appearance must ever do so. The most cursory examination of rates and cost of transportation will reveal this fact. The following table of lake and canal rates is, perhaps, alone sufficient, remembering that what may be called the standard all-rail rate between Chicago and New York is 30 cts. per 100, or a trifle over 0.60 cts. per ton per mile, which rate is often severely cut, sometimes by half or two-thirds. As the average cost per ton per mile of the whole United States was just about 0.6 cts. (for 109 miles average haul) we may be quite certain that the fair proportional cost of hauling such freight by rail is little if any over 0.3 to 0.4 cts. per ton per mile. On the other hand, the ocean rates on grain to Liverpool last year ranged from 2 to 9 cts. per bushel of 60 lbs., for a 3,000-mile haul, averaging about 5 cts., or 0.055 cts. per ton per mile. At 0.1 ct. per ton per mile the steamers feel that they are doing very well, even on flour, which stands about 50 per cent. more per ton than wheat.

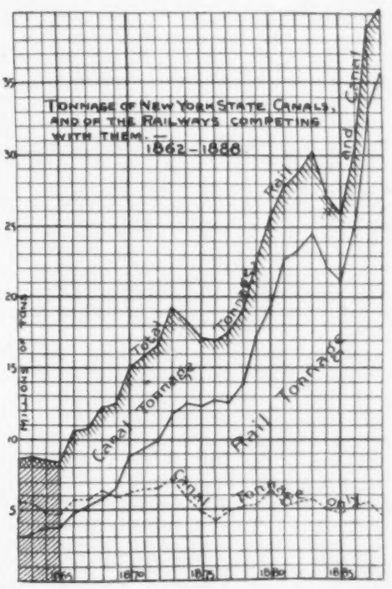


Diagram Showing Growth of Tonnage of the Erie Canal and of the Chief Railways competing with it (New York, Central & Hudson River, New York, Lake Erie & Western—excluding the N. Y. Penna. & Ohio—and Delaware, Lackawanna & Western) 1862 to 1888.

Contrast these figures (all for net tons of 2,000 lbs.) with the figures given below of lake and canal rates: We see at once that in a rude way we may classify the lowest feasible rates of freight as follows, with at least relative correctness:

Long-Haul Rates, Bulk Freights.	*Cts. per Ton Mile*
Small canals, about	0.4
Rail, "	0.3+
Erie canal, "	0.3—
Lake, 14 to 16 ft draught, about	0.12
Ocean, 25 ft., about	0.05+

In evidence of why this difference should exist let us compare one or two items: It has been aptly said, in relation to coal economy in marine steam engines, that if we assume paper to be as good fuel as coal per ton, we have only to "burn this letter" of ½ oz. weight, to propel a ton a mile by steamer; in other words, a ton of 2,000 lbs. will produce 64,000 ton-miles of ship and cargo on the ocean at freight speeds. The same is frequently realized by the best lake vessels. To propel one mile a freight car weighing, with load, 25 tons, takes, on an average, over 5 lbs. of coal, so that on land a ton of 2,000 lbs. only produces 10,000 ton-miles of car and load, or say one-seventh as much. Again, a ship costs only some $50 per ton; a steamer some $100 per ton; and that steamer ton will be good for some 60,000 ton-miles per year, or 600 ton-miles yearly per dollar of capital invested. Were railways equally effective per dollar of investment, the 81,000,000,000 ton-miles and passenger miles made last year in

Lake and Canal Rates on Wheat

Per ton of 2,000 lbs.

	1885	1886	1887	Average	Miles	Cts. per M.
Chicago to Buffalo, Lake	$0.67	$1.22	$1.37	1.09	925	0.118
Buffalo to New York, Canal	1.28	1.67	1.46	1.47	494	0.298
Chicago to New York	$1.95	$2.96	$2.83	$2.56	1,413	0.181
Chicago to Oswego	1.05	1.96	2.34	1.85	1,060	0.174
Oswego to New York	1.16	1.52	1.30	1.31	367	0.357
Chicago to New York via Oswego	$2.16	$3.47	$3.84	$3.16	1,427	0.221
Chicago to Montreal	1.97	2.47	2.83	2.42	1,348	0.179

the United States would represent a capital investment of only $135,000,000. They actually represent a capital of $9,607,000,000.

It is needless to go further. The demand of the age being for quick and cheap transportation, we see at once why the day of great ship canals is so visibly dawning. It is dawning, not only for canals, which save great sailing distances, like the Suez and Nicaragua, but also for canals like the Manchester, which save no distance whatever, but merely compete with railways, saving the disadvantage of breaking bulk. That canal is to be 35 miles long, 26 ft. deep, 120 ft. wide, and to cost, if it uses up all its authorized capital, some $49,000,000. Its actual cost will be at least $35,000,000. Yet Manchester is a city of only 350,000 people, and the tonnage to be benefited by the canal, although as yet largely problematical, is certainly small compared with that which will be tributary to the Nicaragua canal, while the dues must be trifling in comparison.

At least one other canal like the Manchester is likely to be soon started in England; but of course the greatest stimulus to ship canal construction is when more or less sailing distance is also saved, as in the Corinth, North Sea, and Baltic, Cape Cod, and half a dozen others now under way or likely soon to be. And of all canals which ever can be built, it needs only a glance at the map to see that the Nicaragua, or other canal through the Central American isthmus, will save the greatest sailing distances. Even the saving by the Suez canal is small in comparison.

Thus, between London and Canton the Suez saves 3,300 miles (10,000 against 13,300); to Bombay it saves 4,325, and to Calcutta, 3,626 miles, the average saving being about 3,500 miles, while the Nicaragua canal saves from 5,000 to 8,000 miles on most of the voyages likely to be required. Between London and San Francisco it saves nearly 6,000 miles out of a voyage of 13,800; between New York and San Francisco, 8,300 out of a voyage of 13,324; between New York and Canton it is about 500 miles shorter than Suez, and over 5,000 shorter than "around the Horn." As compared with the transcontinental railways, it is only some 60 per cent. longer.*

These are enormous advantages, ensuring that the Nicaragua canal can easily collect 50 cts. per ton or so more than the Suez, or say $2.50 per ton. At ½ ct. per ton per mile, this would only pay railway rates for 500 miles, thus in effect reducing the competitive rail distance to 2,500 miles, or, as nearly may be, half that via the canal *free of tolls*. What possible chance have the railways in a competition like this? A moderately fast line of steamers will make the voyage in less than two weeks, and all but express freights will be sure to go that way, and save time as well as money by doing so, while, more important than all, vast sources of traffic, like ores and timber, of which none is now shipped, will furnish a new and heavy traffic. The larger part of the timber supply of the Atlantic coast, for example, is likely to come from the Pacific coast via the canal.

We deem it therefore an entirely safe assumption that the traffic "in sight" is at most not over half what will exist after the canal has been three or four years in operation. But the traffic "in sight" has been growing rapidly of late years. Estimates, presumably impartial, by the Bureau of Statistics showed as the traffic "in sight":

In 1879	2,647 ships	2,671,886 tons.
" 1885	4,139 "	4,252,434 "

At the present time the most moderate estimates show 6,000,000 to 7,000,000 tons as the probable traffic by 1895. LESSEPS claimed 10,000,000 as the minimum for the Panama canal in late years, but that was certainly extravagant. That it will be attained within much less than ten years after the opening of the Nicaragua canal, however, we regard as almost a certainty.

Now, even 6,000,000 tons at $2.50 per ton means a revenue of $15,000,000 per year. The operating expenses ought certainly to be much less than at Suez, where they are about $1,000,000, so that we may say that the revenue will pay 6 per cent. on some $250,000,000, and 3 per cent. on $500,000,000, with the probability of greatly increasing even these large figures. It is therefore apparent that it really matters little what the canal costs, as respects the expediency of constructing it, unless its cost is to exceed $200,000,000; and let any one with any knowledge of construction look over the profiles and quantities which we publish in this issue, and see where there is reasonable probability of even half that sum being required for construction. The actual cost has been usually estimated at some $60,000,000 to $65,000,000, and we confess we see no reason why those figures *may* not be realized. But we can also see reasons why they may possibly be doubled, and we therefore think the company is eminently wise in not putting before the public at this time any estimate of their own, but simply saying: "Here are the profiles and the quantities; judge of the cost for yourselves."

There will be an inevitable tendency to exaggerate the estimates thus challenged, from remembrance that the $40,000,000 Suez canal actually cost $100,000,000, and the $120,000,000 Panama canal cost over $200,000,000 actual and $350,000,000 nominal to prove that it could not be built at all. But as we showed at some length in our issue of July 14, 1888, the condition at Nicaragua are vastly different from those at Panama. We cannot again go over in detail all the technical differences, but they are of the first importance. There is no unsolvable Chagres River problem; there is much less canal in excavation; there is much less deep cutting; there is no problem of water supply; there is no rotten, sliding rock; there are no endemic pestilences; there is a stiff trade breeze the year round to maintain health and comfort; there is a prior knowledge from detail surveys of just what is to be done which was wholly lacking at Panama; there is the advantage of all the experience gained at Panama, and of an official "base" on this side of the ocean instead of on the other side; and there is the practical certainty of far better management.

These are enormous advantages, and it therefore seems to us that no reasonable man can doubt, first, that the canal can be built for $100,000,000 to $150,000,000 at the very most, and secondly, that it will be exceedingly profitable even at that rate. If so, it is quite immaterial what may be the precise cost of the canal, and the only error to be seriously feared is of *promising* to build the canal for less than really proves necessary, a result which always casts an injurious cloud on an enterprise. But it is not true that carefully made engineers' estimates are not generally safe guides. If any one glances at the top (general) profile on our inset sheet, and sees by the contrast of blue and orange colors how large a proportion of the length of the canal is natural navigation, and how large a proportion of what is left is mere dredging work, involving no uncertainties, he can hardly help deriving a most favorable augury for the success of the enterprise.

We have always felt a regret, and do now, that the Government did not take hold of this enterprise when President GRANT negotiated a treaty to that effect, and recommended it. Such a canal ought to be a great highway of nations, run, not for private profit, but for the profit of a whole nation at least, if not of the whole world. But it was somewhat contrary to our national traditions, although not more than our River and Harbor Improvements were when they first began, and the opportunity has passed. It is worthy of consideration, however, whether even now a true regard for the public interest would not require that the same end should be attained measurably by a Government guarantee of interest on bonds for construction, in return for certain stipulations as to reduction of rates as traffic increases. If the whole conduct and cost of the enterprise be left to a private company, we do not doubt that they will be able to raise the money, but it will cost them 6 to 8 per cent. instead of the 3 per cent. which a Government guarantee would insure; and the company will reasonably claim that, having been left to push the enterprise through unaided, they had a right to enjoyment of the profits of their monopoly, however great, although in the beginning they might have been glad to accept the certainty of a moderate profit rather than the chance of a greater one.

Suez proves, however, that such companies prefer to reduce tolls considerably as traffic grows, merely to encourage its greater growth, and perhaps this alone will serve as a sufficient check. Whatever be done, we are satisfied from all the information we can gather that a few months more will see the main contracts let, the money for construction ensured, and the work which is already begun in active progress; and we confidently look forward to seeing its construction prove one of the most honorable achievements of American enterprise, in broad contrast with the fiasco at Panama, which possibly for the moment may be somewhat of an impediment to the company's negotiations.

*The following table will be convenient for reference in this connection. The distances have been measured by routes most convenient for sailing ships and slow freight steamers. The distances for swift mail and passenger steamers have not been calculated.

	Via Cape Horn.	Via Cape of Good Hope.	Via Nicaragua Canal.	Distance saved.
New York to				
San Francisco	14,840	.....	4 760	10,080
Behring Strait	16,100	.....	7,882	8,218
Alaska	15 500	.....	6,682	8,618
Acapulco	13,071	.....	3,122	9,949
Mazatlan	13,631	.....	3,682	9,949
Hong Kong	18,180	15,301	11,038	4,163
Yokohama	17,679	16,190	9,363	6,827
Melbourne	13,502	13,290	10,000	3,290
New Zealand	12,750	14,125	8,680	5,445
Sandwich Islands	14,230	.....	6,398	7,842
Callao	10,689	.....	3,713	6,976
Guayaquil	11,471	.....	3,053	8,418
Valparaiso	9,750	.....	4,700	5,050
New Orleans to				
San Francisco	15,052	.....	4,047	11,005
Acapulco	13,283	.....	2,409	10,874
Mazatlan	13,843	.....	2,969	10,874
Guayaquil	11,693	.....	2,340	9,343
Callao	10 901	.....	3,000	7,901
Valparaiso	9,962	.....	3,987	5,975
Liverpool to				
San Francisco	14,690	.....	7,508	7,182
Acapulco	12,921	.....	5,870	7,051
Mazatlan	13,481	.....	6,430	7,051
Melbourne	13,352	13,140	12,748	392
New Zealand	12,400	13,975	11,349	2,626
Hong Kong	18,030	15,051	13,786	1,265
Yokohama	17,529	16,040	12,111	3,929
Guayaquil	11,521	.....	5,890	5,631
Callao	10,539	.....	6,461	4,078
Valparaiso	9,600	.....	7,448	2,152
Sandwich Islands	14,080	.....	9,136	4,944

	Miles
San Francisco to W'n End of Nicaragua Canal,	2,578
Valparaiso " " " "	2,518
Callao " " " "	1,531
Portland " " " "	3,219
Victoria " " " "	3,428
New York to E'n End of Nicaragua Canal,	2,021
Liverpool " " " "	4,769
Hamburg " " " "	5,219
Amsterdam " " " "	4,994
Havre " " " "	4,874
Cadiz " " " "	4,220
New Orleans " " " "	1,308

Bridge Floors and the Flat Creek Disaster

It seems to be an ingrained weakness of our poor human nature to take little thought of dangers which we do not ourselves suffer from, either in person or in reputation; and the strongest of all illustrations of this fact, within the range of engineering practice, is, perhaps, the all but insuperable difficulty which seems to exist in getting railways of all classes, new and old, rich and poor alike, to build good floors to their bridges, and properly to protect them against derailment. Perhaps line upon line and precept upon precept, aided by the accident upon accident which is sure to follow, may in time work a change in this respect, and for this reason we have devoted more than usual space to the comparatively trifling accident—only half a dozen or so killed—which happened Aug. 22, near Knoxville, Tenn., which accident was also a comparatively excusable one, in that the road was new and poor, and in a region where the light of good practice has not yet shone as strongly as elsewhere.

Such carelessness is an illustration of our human weakness, because it is so entirely needless, and is so often shown by the richest roads without the slightest excuse of necessity. In fact, one of our greatest trunk lines is one of the worst offenders in this respect. But whether on poor roads or rich roads, the men who are guilty of it—and their name is legion, from State Railway Commissioners down—have no real excuse of necessity or poverty, but are, as the late HENRY WARD BEECHER said about the profane swearer, "selling themselves to the devil *gratis*." We can all understand, and in a measure pardon, the slowness with which those great safeguards, automatic brakes and automatic couplers, are being brought into use. This should not be longer tolerated, but then, the expense involved is great, and will at first result in comparatively little benefit to the pioneers. Each company, therefore, naturally wishes to have others act first, and to come in itself in the eleventh hour, that it may put off the outlay as long as possible, and reap at once its full benefit after it has been incurred. The practical effect is that all alike hold back, though knowing well that it can be but for a time and that there is no longer any real excuse for so doing.

So, too, it is hard to judge severely those companies which are slow about eliminating grade crossings and antiquated terminal arrangements. These improvements involve heavy expense and small operating economies; and their neglect involves danger only to extremely negligent non-patrons of the company. Steam heating is now going in so rapidly that there can hardly be said to be any hanging back in that respect, although there would seem to be some excuse for so doing, as the first cost of the improvement is considerable, and the number of probable deaths saved a small item numerically.

And so we might go through with a long list of other like improvements, in regard to which there is really some excuse for delay although delay ought not to be excused. But in regard to bridge floors, there is no excuse, both because the expense of the best construction and protection is so moderate, and because no concerted or simultaneous action is necessary, even on the same road; but the full proportional benefit is realized from every dollar of expenditure, as soon as made. Yet, if we could (which we cannot) give the list of accidents which have been caused or aggravated by bridges, it would be found that it included an overwhelming majority of the more serious ones, apart from collisions, while nearly all the remainder of any moment would be at points analogous to bridges in their danger, from being on steep side hills. Derailments, we may admit, are a possibility anywhere, especially on such rough track as that of the Knoxville, Cumberland Gap & Louisville Railroad, which we illustrated Aug. 31. It was new and unfit for fast serivce. A year or two from now it will doubtless be vastly better. But a derailment in itself, if the ground be favorable, is not a very serious matter. The thousands of which no one ever hears except the division superintendent, mutely prove this fact. Even if the train be ditched, if the "ditch" be soft and near at hand, little harm is likely to result. The danger comes in almost invariably on the high fills if at all, and the highest of these almost invariably have some kind of open bridge or trestle floor in the middle which greatly aggravates the danger of accident at the most dangerous point.

This being so, it would seem as if the weakest understanding ought to be able to grasp the truth that it is well worth while to make the most dangerous points on the roadbed at least equally safe with the rest of it, so that trains may have at least as good a chance of passing by that point without falling into the yawning gaps as they have of passing the "soft" spots to fall on; but it seems impossible to secure even this small degree of caution, much less the use of the Latimer or other rerailing safety guards, so as to make these points a little safer than the rest. In the case now in question, the floor almost seems to have been ingeniously contrived to give no train a "living chance" of safety if it once went off the track; and this case differs from thousands of others only by having been brought into prominence by an accident to a number of well-known people.

In this case, as will be seen by referring to the plan of the scene of the disaster, published on page 198 of our issue of Aug. 31, the derailment of the first wheel (front wheel of rear truck of rear car) occurred at a shockingly bad joint (See Fig. 4) in a road crossing just 165 ft. from the trestle. It was plainly caused by the whip-lash effect on the rear of a train when running over bad track. In 60 ft. (at *b*) the whole truck came off; in 55 ft. more (at *c*) it slewed off so that the left wheels bore hard against the right rail. *It then continued parallel with the track for* 50 *ft.*, until the trestle was struck, *and for* 30 *ft., further on the trestle* (to *d*), and only then the car tipped over, for the reason that the wheels were hanging over nothing, with the flange just 10½ ins. beyond the end of the 12-ft. tie, as a brief calculation will show, remembering that the gauge was 4 ft. 9 ins. and that the inside clear gauge of wheel is 4 ft. 5⅛ ins.

Now, in the name of common sense and common humanity, if a man will not do anything else to protect a bridge floor, why should he not make a brief calculation like this in advance, and give the wheels a fighting chance to get over alive in the very natural position for derailed wheels to assume, which they did assume in this case, the off rail serving as a guard-rail? To do so means 800 to 1,000 ft. B. M. only per 100 ft. of bridge, a trifling addition to the cost of even long trestles, and for the many small openings, which are equally dangerous to derailed wheels, a mere bagatelle.

Again, it has happened over and over again that ties have 'bunched" as they did in this case, when pushed forward by derailed wheels. The last previous conspicuous instance, where the consequences were very disastrous, was at the St. George disaster on the Grand Trunk Railway. Now, the trestles and bridge-floors throughout the country, where the ties have been so laid down that they are all ready to "bunch" on the slightest provocation are numbered by thousands. There is not the slightest real necessity or excuse for laying them down in this way. By making the stringers one inch deeper, the stringers can be boxed out an inch to receive the ties, and so bunching made impossible. Reluctance to do this is natural, and the chief cause for the bad practice in this respect; but the same end can be obtained, with less trouble and expense, by packing blocks spiked to this stringer, yet how rarely even this is done! It would not have saved this disaster, because the ties were too short at best; but had the ties been longer, or the floor been properly guarded, the bunching alone meant all the difference between probable safety and certain danger, as at the St. George bridge. The only apparent reason why this and other like precautions are not taken is that many constructive engineers seem constitutionally unable to consider in advance operating contingencies with which they do not come in contact. If a floor be only safe for wheels on the track, they think that is enough; and hence we still see on some lines, including one most important one, "floors" which consist merely of longitudinal stringers on which the rails rest directly, without the use of any ties at all. There was a serious accident on one "floor" of this kind, due wholly to its openness, only last week, in Western Pennsylvania.

Again, even when there is some pretence of making a solid floor, as there was in this case, it is extremely common to make the ties 7 x 8 or 8 x 8, and space them 8 ins. apart. In this case the ties were 7 x 8, narrow side up. The inevitable effect is that derailed wheels give every tie a severe blow, and if there be any unevenness of spacing, or a rotten tie, or a chance to "bunch" one or two ties, disaster is always sure to follow. It is not appreciated that the violence of the blow struck each tie varies very nearly as the *cube* of the space between them. It is therefore much better in every way to use a thinner tie more closely spaced, if it appear inadvisable to increase the aggregate of timber; 6 x 8 ties spaced 4 ins. apart require no more timber than 8 x 8 spaced 8 ins. apart, and give a vastly safer floor; if the spacing be reduced to 3 ins. the floor is safer yet, with an increase of only 1-12 in quantities.

Again, a long-tie floor, even with 12-ft. ties, without outside "jack-stringers," is more or less a delusion and a snare. The ends of the ties have little strength. The jack-stringers add but a trifle to the total of quantities, and if capped by a notched guard-rail or cap (for it is not properly a guard-rail) effectually prevent bunching at least. Had there been such a guard-rail at Flat Creek, even if it had no effect upon the wheels, the rear end of the coach might well have ridden across the trestle on it, and not tipped the whole car over.

Again, there never was a better illustration than this of the great utility of flaring outside guard-rails, terminating in a heavy collision post, such as is shown in the standard floor of the New York, Ontario & Western Railway in our issue of Feb. 12, 1887, and Jan. 28, 1888, and the absence of which from the recommendations of the Massachussetts State Board of Railroad Commissioners we took occasion to deprecate in our issue of Dec. 31, 1887 Except that there was a fence to serve as an impromptu guard-rail in the Bradford, Mass., disaster (See ENGINEERING NEWS, Jan. 14 and May 19, 1888), that also would have been another Flat Creek smash-up. There never was a plainer proof than is given by these two occurrences that insi

guard-rails alone are not sufficient. It is anything but rare for wheels to assume just the position that they did at Flat creek. Some fossil railroad man from the vicinity of Boston must have advised the Commission badly.

Finally, the most important moral of all is one which we have sought to enforce so often that we are somewhat weary of that form of well-doing, albeit we knew it is bearing no little fruit. Had the bridge been provided with the Latimer rerailing safety-guard, in addition to outside guard-rails and a good floor, the train would not only have had a fighting chance to pass the trestle unwrecked, but would in all human probability have been replaced upon the rails and gone ahead, none the worse, without a stop. To use it requires just $7.50 worth of cast-iron at each end of the bridge. We cannot now take space to rehearse the arguments in its favor, however, but must refer our readers to what we said on this subject on Feb. 12, 1887, Jan. 14, 1888, and in numerous other issues, again commending the subject to careful attention. If we cannot learn until after the event, let us at least learn from other people's events, and not wait to have them come nearer home, to our just confusion and disgrace.

CORRESPONDENCE.

Steubenville Bridge Accident.—Correction.

STEUBENVILLE, O., Sept. 4, 1889.

TO THE EDITOR OF ENGINEERING NEWS:—

In your issue of Aug. 31, 1889, there is a report of a bridge accident at Steubenville, O., on the Pittsburg, Cinn. & St. L. Ry. In your report you state that the cause of the accident was the breaking of a rope. This is an error, which I think you should correct, as it conveys the impression that I was using poor or unsafe rigging, whereas, on the contrary, I am using the very best rigging that is to be had in the country. The line I was using was new; had not been in use more than two days. The real cause of the accident was one of the workmen, who was holding the turns on the steam winch, letting the line slip out of his hands. There was no rigging of any kind which broke or gave way in any manner. By correcting your previous statement you will greatly oblige Yours truly,

D. MCCAULEY.

Dam Inspection in Connecticut.

BRIDGEPORT, CONN., Aug. 31, 1889

TO THE EDITOR OF ENGINEERING NEWS:—

I was much interested in your late editorial on supervision and inspection of dams, and please accept my congratulations on the very able manner in which you handled the subject. I received to-day from the State Commissioner of Rhode Island his report from 1864 on the dams and reservoirs of that State.

We have made quite a number of inspections at the request of the owners. I made an inspection of two dams last week. The Stamford Water Co. are now rebuilding one dam, making the spillway 54 ft. long in place of 38 ft. I have had only one such case. The Stillwater dam at Stamford, about a mile above the village, I had to condemn. It was 18 ft. high and 300 ft. long, and in a very bad condition. There were three wooden gates in a bulkhead on one end of the dam, both bulkhead and gates much decayed and the main dam weak. Upon complaint of the selectmen of the town, I made an inspection, and ordered the gates taken out until such repairs are made. In the meantime the reservoir will remain empty. Almost all the well owners and water companies desire these inspections to be made. It is for their interest to have it done. ENGINEERING NEWS is doing good work on this question and many others and may success attend its efforts.

Yours truly,

B. H. HULL

Lesser Railway Structures, Canadian Pacific Railway.

TO THE EDITOR OF ENGINEERING NEWS:—

Referring to the drawings reproduced by Mr. GIRONARD, and published in part by your journal of 24th ult., I beg to say that the universal practice of the Canadian Pacific Railway is to use 31-ft. stringers to their 15-ft. Bent trestles, breaking joints alternately, and lap jointed—and always a cast-iron packing washer between them; but in the State of Maine, 16-ft. stringers were resorted to on portions of the line, owing to the impossibility of getting suitable stringer timber 9 x 15 ins., or 8 x 16 ins. 31 ft. long, except to a limited extent. The only alternative was the use of Southern pine to a considerable extent for this purpose, toward Brownville and Mattawamkeag; but the expense was large.

White pine, brought in from Canada and delivered to points required, in advance of tracklaying, was found to be prohibitively expensive.

As to the framed Timber Open Culvert, showed in Fig. V, 8 ft. was the maximum height allowed. They were designed as a combined culvert and cattle guard, to be used where piles could not be driven, in a very hard bouldered soil or rock bottom. Indeed, but very few, if any, of this type were actually built in the State, the drawing being furnished *exempli gratia*.

Yours truly,

R. F. TATE, M. Can. Soc. C. E.,
Chief Draughtsman on Construction C. P. Ry. Maine Short Line.

Notes and Queries.

W. H. W., 112 No. 4th St., St. Louis, asks: I have been looking through the various engineering journals for what I believe to be the "Burns Automatic Air Lock Bucket," used in putting concrete in caissons being sunk by air pressure. Will you have the kindness to inform me where such a bucket can be had, and who are the manufacturers?

Any of our readers who can give him the information will please address him direct.

The Brooklyn Bridge.

At the last meeting of the Board of Trustees of the Brooklyn Bridge, Sept. 9, Trustee GEO. W. MCNULTY, from the committee appointed at the July meeting to report upon the question of additional terminal facilities, made an address stating that the committee regretted that the plans so far adopted had provided for only doubling the present capacity, which was not enough, and then submitted the subjoined resolution. Mr. MCNULTY said in part:

To my mind no question has ever come up since the construction of the bridge was determined upon and undertaken comparing with this in importance to our citizens, nor one involving greater interests to the two cities. That the unprecedented and unequaled growth of the passenger traffic was not foreseen and amply provided for by the builders of the bridge in nowise detracts from the credit which is their due and is so freely accorded them for the good and enduring work they did do. So with the management. Since the opening of the railway in 1883 all that could be done with the terminal arrangements as constructed in providing for the accommodation of the ever-increasing travel has been done. Under this management and by the existing method of operating the railway, 134,000,000 passengers have been safely transported on the bridge, 159,259 on April 30, 1889, and 14,000 in a single hour. This is by far the greatest passenger traffic in the world between any single terminals.

If, for lack of precedent only, our predecessors failed to fully grasp the great and really unique problem of transportation, and may on this ground be excused, we, in the light of six years' experience as a guide, can plead no such excuse. The necessities are now clear to us all. They must be met. The demand is imperative. It is our duty, and the responsibility rests with us, as trustees, to see that the main object of the construction of the bridge is realized in the fullest and broadest sense.

The entrance to the approaches to the bridge and their surroundings are now not only discreditable, but positively disgraceful. In no other of the great cities of the world would such a state of affairs be tolerated for a day. An absolute and radical change is imperatively demanded, and such is proposed by the committee.

Three years hence our city will be visited by hundreds of thousands of strangers from all parts of the world. To a great majority of these, it is safe to say, the bridge will be an object of interest to them second to none. Many will find a temporary home in Brooklyn, and it is therefore extremely probable our railway facilities will be put to the test at this early date. This makes the demand for improved facilities all the more urgent. I beg, therefore, to offer the following for adoption:

Whereas, The traffic on the New York and Brooklyn Bridge has increased much beyond what was originally estimated and provided for, and doubtless will steadily continue to increase, while the facilities therefor, though from time to time extended, still fall far short of adequately transporting the possible maximum travel over the structure itself: and

Whereas, The stations now in use are unsuitable in plan and unfitting in architectural design, forming unsymmetrical and inappropriate portals to a grand engineering work: and

Whereas, Plans for improving terminal facilities, including the erection of new stations, one in New York and one in Brooklyn, have, on the recommendation of three different committees, been separately adopted by the trustees.

Resolved, That four trustees be appointed by the President, and constitute, with himself as ex-officio member, a Committee on Improved Traffic Facilities of the New York and Brooklyn Bridge, which committee shall consider the plans and means necessary to provide such facilities for transporting the traffic over the bridge as will permit the maximum possible travel on its several lines of communication, the railway, roadways, and footway, to be handled with comfort, safety, rapidity, economy, and without delay, including designs for the stations required, suitable for the uses intended and in harmony architecturally with the structure proper. Such committee to enter promptly on its work, and report to this board at an early meeting, recommending plans necessary to fully effect the improvements herein outlined, with detailed estimates of the total cost, and a scheme for the rapid and complete execution of the plans recommended.

After defeat by a vote of nine to six of a resolution referring the whole question to the Executive Committee with power, this resolution was adopted. Mr. MCNULTY, in his remarks, expressed his confidence that the plans previously submitted by Chief Engineer C. C. MARTIN could be expanded to accomplish necessary ends, and remarked that "an ideal train service would be from center to center of the two cities," a remark which is taken by the press as pointing to a renewal of President HOWELL'S past efforts to extend the Brooklyn terminal to the City Hall, where he is reported to have certain large real estate interests. This project has heretofore been severely sat upon by the Brooklyn press and people, and in our judgment properly.

The secretary's traffic statement for the month of August showed gross receipts of $80,843.60, an increase of $10,647.39 over the corresponding month of last year. The number of cash fares at one cent for the promenade aggregated 144,331, and for the railroad, at three cents, 1,368,313, a total of 1,512,644. At 25 for 5 cents, 164,800 promenade tickets were sold, and at 10 for 25 cents 1,285,960 railway tickets.

Thus it will be seen that, although the traffic of the bridge is largely by regular patrons and not by transients, as shown by the enormous excess of travel before and after business hours, a large majority of the passengers (1,368,313 against 1,285,960) prefer to pay 3 cents per trip than pay for 10 trips in advance at the rate of 2½ cents, and have the trouble of guarding their tickets. The neglected saving would be 16⅔ per cent., or one cent per day. On the promenade the contrast is still more notable. Only 164,800 tickets at 1-5 cent each (25 for 5 cents) were sold, while 144,331 paid a cent each to cross.

The Water-Ways Convention.

The meeting of delegates from 12 States was held at Cincinnati, O., on Sept. 5. Capt. C. M. HOLLOWAY, of Cincinnati, was appointed Permanent Chairman, and Mr. EDWARD STEVENS, of Cincinnati, Permanent Secretary. The report on rules and order of business was submitted. It sets forth that the deliberation of the convention shall be confined to the improvement of navigation on the Ohio, Mississippi and Missouri rivers and their tributaries.

The Committee on Resolutions presented their report through their chairman, J. H. MURPHY, of Missouri. The convention deeply regrets the failure of Congress to make the necessary appropriations at its last session for continuing the improvement of western waterways. It is declared the duty of Congress to improve and protect all the waterways of the nation. Where private individuals or corporations have assumed or secured, by state action or otherwise, privileges on such waterways to the injury of commerce, the removal of such obstructions is asked. The convention heartily approves the connection of the waters of the upper Ohio river with the great northwest lake system through the waters of Lake Erie, by the construction of a ship canal, if, upon a survey, the same be found practicable. The action of the Executive Committee on the improvement of western waterways was commended, and the committee requested to continue its work.

THE ADMISSIONS TO THE PARIS EXHIBITION to July 31, or rather, the tickets used, number 10,022,000 as compared with 5,116,000 during the corresponding period in 1878. In 1878 the admissions up to the close of the exhibition numbered 12,000,000, or 2,000,000 more than in 1867.

The Abandoned Works at Panama.

A letter from Panama in the New York *Times* of Sept. 9 gives the following graphic account of the state of affairs along the line of DE LESSEP'S unfortunate ditch.

For 25 cents in Columbian silver one may hire a small one-horse victoria, with a negro driver, to take you to the mouth of the canal at Panama. The drive is about two miles, on a road well shaded with all varieties of tropical trees, and is well worth taking, even if you do see nothing but a dirty ditch at the other end. The work at this "show point," so to speak, was so slovenly done that it is difficult to distinguish the lines of the canal at high water, and at low tide it has no more water than a New Jersey mud flat. Further inland, passing a few dredges, the bed of the cut becomes a pasture for the cattle in the vicinity, and a few steps further along bring you to banana trees growing in the track of the commerce of the world. On the entire line there are now regularly employed 100 men. They are watchmen, who guard the company's property, and others who carry paint-pots to paint the hundreds of rusting engines. Near the Culebra cut there must be fifty-odd fine engines, which, with their fresh coats of paint, present quite a prosperous appearance, in strong contrast to that of two years ago, when everything was going to rack and ruin through criminal neglect. The engines and iron work I formerly saw half buried in the mud at the foot of the mountain are now out of sight, probably to be unearthed by future generations of canal builders, and to be regarded as evidence of the ingenuity of their ancestors as far back as the nineteenth century.

Except the few Frenchmen who still receive salaries, I found no honest believers in the future success of the canal beyond some half-breed French and Spanish youngsters who were formerly salaried also by DE LESSEPS, but who now have minor positions as freight clerks for the steamship lines, and their belief is strongly aided by their desire to again secure the sinecures they have lost. Even the press of the isthmus has dropped off in its zealous support of DE LESSEPS since the sums of money he sent from France have dwindled to nothing.

One of the best indications of the abandonment of the enterprise is the immense falling off in the importation of all food supplies. The Pacific Mail formerly brought great quantities of rice, but their steamers now carry less than one-sixth of the amount carried five years ago. The large firms on the isthmus still hold on, barely paying expenses, while the smaller concerns are either closing out or going to the wall. Chinese shops along the works are gradually closing up, and when a Chinaman leaves a ship, she must be sinking.

The American Dredging Company skimmed the richest cream, and is now sending its machinery to be used on the Nicaragua route. How the French storekeeper accounts, even on paper, for his material is a mystery even to an army quartermaster. Engines here on their backs and engines there on their sides may all be accounted for, even if the chaos of the Culebra cut does not remind one of the Johnstown disaster; but for the buried ironwork and machines he has only one recourse, i. e., to dig down to them now while they are not deep under ground; attach a chain to them, having on the upper or the surface end an automatic sounding buoy, to determine their position in the next overflow of the Chagres, and to continue the same plan with those that will be buried annually as the years roll by.

The Railways and the Public.

By permission of the author and publishers, we are able to present to our readers some extracts from the volume just published by G. P. Putnam's Sons, entitled "Monopolies and the People," a notice of which will be found in our "Publications Received" column. The author gives an especially full discussion of the subject of railway competition, and aims to do so from an impartial standpoint. The following extracts are condensed from Chapter IV, on "Monopolies of Transportation and Communication."

It is plain that no more than a century ago the world had comparatively very little need for railways. Each community produced from its farms and shops most of the things which it needed; and the interchange of goods between different sections, while considerable in the aggregate, was as nothing in comparison with modern domestic commerce. The king's highways were open to every one, and though monopolies for coach lines were sometimes granted and toll roads were quite common, there was no possibility for any really harmful monopoly in transportation to arise, because the necessity of transportation was so small. Some writer has ascribed all the evils of modern railway monopolies to the fact that in their establishment the old principle of English common law, that the king's highway is open to every man, was disregarded. But if we sift down this ancient maxim of law to its essential principle, we find it to be, *there must be no monopoly in transportation;* and the problem of obtaining the advantages of modern railway transportation, and keeping up, at the same time, the free competition that exists in transportation on a highway, is seen to be as far from its solution as before.

The author then explains the importance of the railway traffic. He estimates that 10 per cent. of the total wealth annually produced in the United States is paid for railway transportation. He also declares that the railway is an absolute necessity to our present civilization, and proceeds to discuss the possibility of fixing the price of this important and necessary commodity by free competition.

There are now in the United States about 37,000 railway stations where freight and passengers are received for transportation. Now, from the nature of the case, not more than 10 per cent. of these are or can be at the junction of two or more lines of railway. (By actual count, on January 1, 1887, eight per cent. of existing stations were junction points.) Therefore the shippers and buyers of goods at nine-tenths of the shipping points of the country must always be dependent on the facilities and rates offered by a single railway. Such rates of transportation as are fixed, be they high or low, must be paid, if business is carried on at all. And when we consider the 10 per cent. of railway stations which are, or may be, junction points, we find that at least three-fourths of them are merely the junction of two lines owned by the same company. Consolidation of railway lines has gone on very rapidly within the past few years and is undoubtedly destined to go much further. Of the 158,000 miles of railway in the country, about 80 per cent. is included in systems 500 miles or more in extent; and a dozen corporations control nearly half of the total mileage. The benefits which the public receive from this consolidation are so vast and so necessary that no one who is familiar with railway affairs would dream of making the suggestion that further consolidations be stopped or that past ones be undone.

The author then explains how unwise are the ideas of those who would prevent further railway consolidations.

Assuming that the total number of railway junction points in the United States is 3,000, we find, on examination, that at about two-thirds only two lines meet, and at more than half the remainder only three lines meet. It is plain that in the vast majority of cases where two roads intersect, and in many cases where three or four come together, the lines meet perhaps at right angles and diverge to entirely different localities. The shipper bringing goods to the station, then, may choose whether he will send his goods north or east perhaps; but only in the few cases where two lines run to the same point does he really have the choice of two rates for getting his produce to market. Practically, then, there are not, and never can be, more than a few hundred places in the country where shippers will be able to choose different routes for sending their goods to market. We say there never can be, because the building of a line of railway to parallel an existing line able to carry all the traffic is an absolute loss to the world of the capital spent in its construction, and a constant drain after it is built in the cost of its operation. This fact is now, fortunately, generally appreciated.

But what of the competitive traffic which exists between commercial centres, like the trunk-line traffic between Chicago and the cities on the seaboard, or between the former city and the collecting centers farther west, like St, Paul, Omaha, and Kansas City? Here, indeed, there is competition; and it is of great importance because of the enormous bulk of the traffic which traverses these few routes.

It is a peculiar feature of the railway business which we have now to consider, and one which is not generally understood. We have already perceived the principle that competition cannot permanently exceed a certain intensity; and the proof of this principle in the case of the railway is remarkably plain. Suppose two roads are competing for the traffic between Omaha and Chicago. A shipper at the former city who wishes to send a few tons of freight to Chicago may go to one company and ask their rates, then to the other and induce them to give him a lower rate, and then back to the first again, until he secures rates low enough to suit him. Now, it is a fact that either company can afford to carry this especial freight for less than the actual cost of carrying it better than it can afford to lose the shipment. This is because it costs the company practically *no more* to carry the goods than if they were not shipped by its line; and hence whatever is received for the freight is so much profit. Stated in the form of a principle, this fact is expressed thus: *Receipts from additional traffic are almost clear profit.* Nor is this all. The practical impossibility of distinguishing *additional* traffic from other traffic, and the enactment of State and National laws requiring uniform rates to be charged, places all traffic on a common basis; and the same cause which makes it more profitable to carry additional traffic for a song than to lose it, makes it better for a railroad to carry traffic, temporarily at least, for less than the actual running expenses of the road, rather than to lose it. The train and station service, the general office and shop expenses, must all be kept up, though the freight and passengers carried dwindle to almost nothing; and the capital invested in the road is a total loss, unless the line is kept in operation and earns some income, even though it be small. This last influence, as we shall see later, is a most important and far-reaching one in its effect on industrial competition.

The cause of the intensity of competition in railway traffic is now evident. And from what we have seen, it follows that two railway lines competing freely with each other cannot possibly do business at a profit. Let us see what are the actual results of this law of practical railway management. Evidently the managers of two competing railway lines have but two possible courses open. They may, by tacit or formal agreement, unite in fixing common rates on both the roads, or they may attempt to do business with free competition. But we have already proven that the latter course must result in reducing the income of the road certainly below the amount necessary to pay the operating expenses and the interest on the bonds, and probably it will be insufficient to pay the running expenses alone. The inevitable result, then, is the bankruptcy of the weaker road, the appointment of a receiver, and its sale, in all probability to its stronger competitor. This is the chain of cause and effect which has wrought the consolidation of competing parallel roads in scores of cases, and which, if free competition is allowed to act, is sure to do so.

We can now appreciate the *necessity* which managers of competing lines are under to agree upon uniform rates for traffic over their roads, and at the same time the difficulty of doing this. This strange paradox is true that while it is *necessary* to the continued solvent existence of the competing corporations that such an agreement be made, it is also greatly to their advantage to break it secretly and secure additional traffic. It is necessary, therefore, that the parties to the agreement be strongly bound to maintain it inviolate; and to effect this, "pools" were established. In pooling traffic, each company paid either the whole or a percentage of their traffic receipts into a common fund, which was divided among the companies forming the pool, according to an agreed ratio. Under this method it is evident that all incentive to secret cutting of rates and dishonest methods for stealing additional traffic from another road was taken away.

A quotation is then made from CHARLES FRANCIS ADAMS on railway combinations; and the Interstate Commerce Law and its effects are briefly considered. From this discussion the author comes to the following conclusions:

It must now be clear that the railway is essentially a monopoly, not, be it noted, because of any especial wickedness of its managers or owners, but because competition is *impossible* as regards the greater part of its business, and because, wherever competition is possible, its effect, as the managers well know, will be to annihilate all profits from the operation of the road.

The evils due to railway monopolies are then taken up, and local and personal discrimination and "charging what the traffic will bear" are discussed.

There are two evils of our present railway system, however, which are not chargeable to monopoly, but to the attempt to defeat monopoly, and which are important to our discussion. The first is the waste of competition in railway traffic; the second, the waste of competition by the construction and threatened construction of competing lines where present facilities are ample for the traffic. Of the first it need only be said that in advertising, "drumming," and soliciting patronage the railways spend many millions of dollars every year, which comes out of the pockets of the public. The second is more serious, for it involves a far greater waste. It is a conservative estimate to say that five per cent. of the railways of the country were only built to divide the profits of older roads, and that their owners would be delighted to-day to have their money back in their possession and the railroad wiped out. The millions these roads have cost, the millions required every year to maintain and operate them, the millions spent on proposed roads that never reached completion, and the millions squandered in fighting proposed roads by every means short of actual bloodshed,—these are some of the wastes which we have made in our endeavor to create competition in railway transportation. And with all our efforts, and notwithstanding the fact that until within a short time the public sentiment and the railway managers have been united in the belief that free competition was the only mode of regulating railroad rates, we are farther removed from free competition now than ever before.

And now consider, in addition to all this, the fact that every railway company must first of all secure from the State a right to exercise the sovereign power of Eminent Domain, and that it may and does choose and take every advantage of the favorable locations where its road can be built most cheaply; which natural highways, moun-

tain passes, and the like, are gifts of nature, the right to whose use equitably belongs to the general public, and not to private parties exclusively. Taking these facts into consideration, it seems needless to offer further proof of the fact that the business of railway tranportation is essentially a monopoly, and that the attempt to regulate it by competition must always prove a failure in the future, as it always has in the past.

The chapter then continues with a discussion of the general nature of transportation monopolies and of other monopolies of the same class as the railway.

In the concluding chapter of the book the author outlines plans for the equitable and permanent adjustment of the relations between all the various monopolies discussed and the public. The scheme presented for settling the railway problem is described at considerable length. We have not space to reproduce it here, but the cardinal principles of the plan are as follows:

(1) Government protection to the owners of fixed capital, so that the public may obtain the use of it at the lowest possible rate of interest. (2) The operation of monopolies by corporations rather than by the Government, thus securing the increased efficiency of private over official management. (3) Securing to the people at large the benefit of the monopoly by basing the prices for its product on cost of service. (4) But leaving a suitable incentive for the company's managers to maintain economy and efficiency in its operations. (5) Government representation in the directorate controlling the ordinary affairs of the company.

It should be explained that, although the author proposes to have the Government guarantee the interest on the fixed capital invested in the railways, his plan is so devised that the Government is not to assume any risk in so doing.

The editors greatly regret that the circumstances make it impossible for them properly to review this volume, whose merit and interest will be at once appreciated by every reader, even if he do not fully agree with all the opinions expressed. Its subject matter is rapidly becoming the great question of the day, and no one can read the work without being helped to a clearer comprehension of it.

Proper Tests for Cast Iron.

By J. B. JOHNSON, Professor of Civil Engineering, and Director of Testing Laboratory, Washington University, St. Louis.

Cast-iron is one of the most useful of metals, but one of the most variable in its qualities. Its strength in simple tension varies from 15,000 to 30,000 lbs. per sq. in., or 100 per cent., while its toughness, or ability to resist a shock or blow, varies by over 600 per cent.

For ordinary foundry purposes cast-iron should be soft, to allow easy working under tools; and tough, to resist the effects of shock. It is probable that cast-iron breaks nine times from some kind of jar or blow to once from a static load; and hence its ability to resist a shock is many times as important as its ability to resist a dead load.

Now, when cast-iron is tested for strength, whether in tension or in cross-breaking, only its ability to resist a quiescent load is determined. Such a test gives no information as to the strength of the iron to resist a shock. It often happens that the strongest iron is the most brittle, or the least able to resist a jar or blow.

Again, when cast-iron is tested by the impact test, or by letting a body fall upon it, every blow causes a permanent set or distortion, and so permanently weakens the specimen for resisting other blows, so that when the specimen breaks, the test only shows how much strength was left in the body after the previous blows had been given, and not how much was in the material in the first place.

There is, therefore, but one way in which to determine the original resistance of the body to shocks, and that is by testing to rupture with a gradually applied load, either in tension or in cross-breaking, and observing its distortion under this breaking load. This distortion is a simple stretch in case of a tension test, and deflection in the middle in case of a cross-breaking test. Both methods are competent to determine the absolute resistance of the body to resist a shock.

The resistance to shock depends on both the strength and the amount of distortion, or "give," the body will take before rupture. A body which will not bend or distort under a load is said to be brittle, and brittleness is weakness when a shock is to be resisted. When two rigid bodies come together at an appreciable velocity, the force of impact is less as the distortion or spring of the materials is greater. If the bodies were absolutely rigid, that is, if they would not distort at all, the force of impact would be infinite, so long as the weight and velocity of the bodies were appreciable.

That quality of a material which enables it to resist a shock or blow is called its resilience, or spring. It is not strength, which is measured in pounds; not distortion, which may be measured in inches: but it is the product of both strength and distortion, and is therefore measured in inch-pounds. That is to say, resilience, like work, can only be measured by a unit which includes both distance and force, as inch-pounds, or foot-pounds.

A body weighing 10 lbs. and falling 10 ft. or 120 ins. has stored in it $10 \times 120 = 1{,}200$ in. lbs. of energy, or it is then able to do 1,200 in. lbs. of work on some other body. If this body should now strike a bar of cast-iron, for instance, the iron must be able to develop more than 1,200 in. lbs. of resilience, or spring, in order to absorb this energy without breaking.

Now, the resilience of a bar of cast-iron in cross-breaking is one-half the product of the breaking load into the final deflection. That is, the load increases from zero to the breaking limit while the deflection is being caused, and the total work done on the bar is the mean or average load, multiplied by the total deflection.

If the load be measured in pounds and the deflection in inches, then the half product is given in inch-pounds.

If the bar be supported at its ends, and broken by a load in the middle, then the whole bar contributes to the deflection, and hence the resilience or resistance to shock of the whole bar is obtained. If we now divide the half product of the breaking load into the final deflection by the weight of the bar in pounds, the result will be the resilience of the material in inch-pounds per pound of iron.

This result is independent of the particular dimensions of the bar, but does depend on its form. For plain rectangular bars, of uniform size from end to end, the result should be the same, when the same iron is used. A different result would be obtained for a round bar; but all rectangular bars of the same iron should give the same result, whether flat, square, or broken across in the direction of the greater dimension.

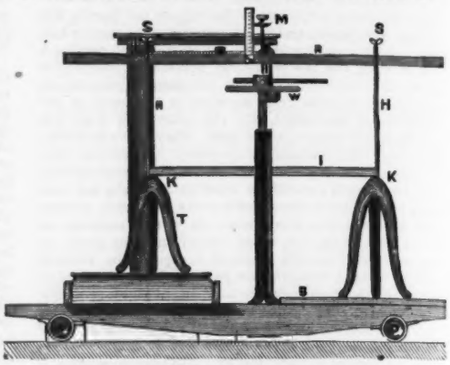
By this rule no attention need be paid to the dimensions. Take any plain rectangular bar, of any length and of any cross-section, so long as it is uniform from end to end. Break it by a load on the middle, and measure the breaking load in pounds, and also the deflection in inches. Take half their product and divide by the weight of the bar in pounds. The result will vary from 10 for the most brittle and worthless iron to 70 for the strongest and toughest. A result of 25 will correspond to the lower grades of ordinary foundry product, such as is used in water and gas pipes, while a result of 40 to 50 will correspond to the better grades of machine castings. Stove irons should give a result from 50 to 70.

With this rule, any foundryman could determine the quality of his own mixtures, if he only had a convenient machine for making cross-breaking tests, which would give both the breaking load and the deflection.

The writer has now designed such a machine, to operate as an attachment to an ordinary pair of platform scales. It is the weighing part of a testing machine which is the principal source of expense. By utilizing the ordinary platform scales, therefore, the cost of such a machine is greatly reduced.

The cross-breaking testing machines now on the market cost from $100 to $150, and have no means of measuring the deflection. These are quite worthless, therefore, for making tests of iron to resist shocks or blows, this being the quality which is many times as important as the simple strength of the metal.

The machine designed by the writer is shown in accompanying figure, being a side view. It is put on rollers and is intended to have one end of the base *B* run under an ordinary platform scales, which may have to be set up on blocks for this purpose. The two tripods *T* rest, one on the top of the platform of the scales and the other on the base *B* of the machine at the opposite end. The specimen to be tested, *I*, rests on the knife edges *K*, forming the tops of the tripods. These tripods are movable to suit different lengths of specimens. The load is applied by the hand wheel *W*, or by a lever through its capstan head. To the tops of the tripods are rigidly fastened uprights, *H*, which carry the reference beam *R*, which is clamped in position by the thumb screws *S*. As the load is put on and the power screw goes down, the micrometer screw *M*



Platform Scale Testing Apparatus for Cast Iron.
Prof. J. B. JOHNSON, *Designer*.

may be turned down to make a contact with the top of the capstan head. This screw registers, by the aid of the adjoining scale and graduations on the head of the screw, to the nearest 0.001-in. through a distance of 5 ins. By reading the position of the screw when the load on the specimen is zero, and again when any given load is on, the deflection for that load is obtained to the nearest 0.001-in. The half load is given by balancing the scale beam, provided the specimen is put with its middle point under the screw, which should always be done.

Since the ordinary platform scales register from 1,000 to 2,000 lbs., we are enabled in this way to break specimens requiring a load of from 2,000 to 4,000 lbs. which is quite sufficient for any ordinary test of cast-iron in cross-breaking. That is, 2,000 lbs. load in the middle will break the best cast-iron bar 1-in. sq. and 16 ins. long, or 1¼ ins. sq. and 54 ins. long. These machines are now manufactured, tested, and sold under the writer's special direction. They are accompanied by printed rules and instructions which will enable any foundryman to test his own iron at his works, by the most approved scientific method, and so prove the value of his mixtures to his own satisfaction. It is becoming common, also, for users of cast-iron to specify certain tests of strength; and this practice will become practically universal as soon as the means of making such tests are generally available.

The price of this machine is so low, and its adaptation to the work so simple and perfect, that it is hoped it will be generally introduced, and that the new rule given above for showing the resilience or shock-power of the iron will be universally adoped.

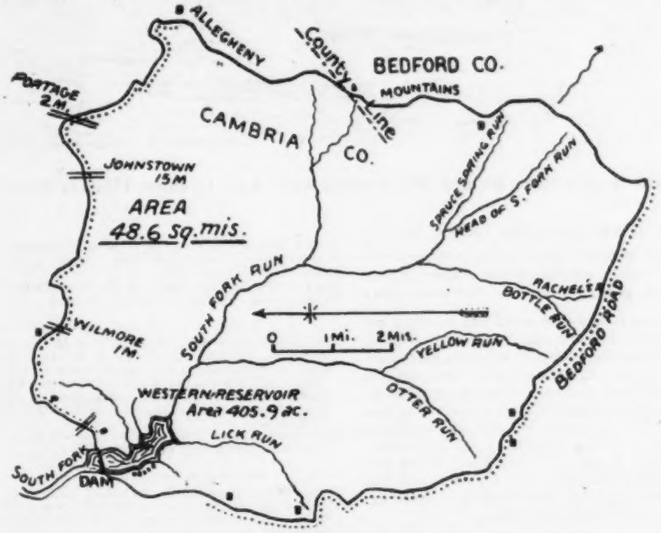
The writer has recently contributed to the American Society of Civil Engineers a paper on Tests of and Specifications for Cast-Iron, a copy of which will be furnished on application, as soon as it appears. He hopes to help bring about a reformation in the scientific study of this material which, though of almost universal use, has been largely overlooked by our scientific investigators in their zealous and astonishingly profitable labors on wrought-iron and steel.

Any further information concerning the new testing apparatus, or the methods of using the same, or the limits of strength and resilience to use in specifications for cast-iron, will be cheerfully furnished by addressing the writer at the address given at the head of this article.

CELLULOID is to be used as a sheathing for ships in place of copper. A French company now offers to supply sheathing of this substance 1 millimetre thick at a cost of 9 francs per sq. metre. Experiments lasting 5 or 6 months show that barnacles and other marine vegetation will not form on a surface covered with celluloid.

The Drainage Area of the South Fork Basin.

We complete our record of the technical features of the terrible Johnstown disaster by the accompanying map of the South Fork reservoir and watershed, for which we are indebted to Mr. A. Y. LEE, C. E., of Pittsburg, Pa., he having made a complete survey of the basins, and the only one, we believe, which has been made. To fully answer all requirements, there should be contour lines on such a basin, and notes of the exact rainfall, discharge of spillway, and rate of rise in the reservoir before the water began running over the top of the dam; but the most essential of these data being forever lost, the mere addition of contour lines to this map would be of little value. The main fact that we can be sure of is that, with a mountain watershed of this area and a reservoir of this size, the original spillway provided for the dam was nearly, if not quite, enough for perfect safety, while the obstructed



The Watershed of the South Fork Reservoir.

spillway, as it was when the dam broke, was less than half large enough.

It will be seen that Mr. LEE gives the watershed from actual survey as 48.6 sq. miles. In our issue of June 15 we gave it, on the authority of a planimeter measurement of an old county map, which we were fortunate enough to discover (the only such map ever made) as 56.6 sq. miles, an excess of 8.0 sq. miles or 16½ per cent. The area of the reservoir we gave as 400 acres, and it proves on survey to be 405 acres, doubtless because of using a somewhat higher water level.

The general character of this water level is less rugged than might be expected from its location, at the very crest of the Allegheny Mountains. Judging from what could be seen of the watershed from the heights in the vicinity of the reservoir, which was perhaps half of it, it is fully half cleared land, with a gravelly soil, with little or no rock in place cropping out, and with only a very limited area so steep that cultivation is not readily practicable on it. On the other hand, there is practically no level land in it,—all has sufficient slope to throw water rapidly off it into the streams; but, taking the watershed as a whole, we should hardly say that it was likely to shed water much more rapidly than others of its size in ordinary hilly country. At least, it tends to safety to assume that it would not, although there may be few such basins not on the side of a mountain range where the water is helped along quite so continuously by unbroken descents.

All further details about the watershed and reservoir which are likely to be required were given in our issues of June 15 and 22, and need not be repeated here.

THE PENNSYLVANIA CANAL, built by the State of Pennsylvania in 1830 and now owned by the Pennsylvania Railroad Co., is to be finally abandoned. Along certain sections the tracks of the railroad are to be transferred to the canal bed.

The Mercantile Shipping of the World.

The following series of tables is obtained from the "Universal Register" for 1888, which has recently been published, and is fully abstracted in *Industries* from which we again condense.

Table I. shows the total number and tonnage of sea-going vessels owned by all the countries of the world in 1888, and, as in previous years, is based on the net register tonnage of sailing vessels and the gross tonnage of steam vessels, excluding sailing vessels below 100 tons net register and steam vessels below 100 tons gross register. During the triennial period 1885 to 1887, there was a decrease both in the number and tonnage of mercantile vessels afloat; but while in 1888 there is still a decline in the number of vessels, the decrease for the year being 538 vessels, there has been an increase in the combined tonnage of steamers and sailing vessels of 283,059 tons. Evidently the building of larger vessels has continued, and this has been a marked feature in vessels owned in the United Kingdom, the average tonnage of such vessels having risen to 1,055.4 tons, as against 1,004 tons, 907.14 tons, and 928.64 tons in the years 1887, 1886 and 1885 respectively.

TABLE I.

TOTAL NUMBER OF ALL SEA-GOING VESSELS FOR ALL COUNTRIES OF THE WORLD IN THE YEAR 1888.

	No. of vessels.	Tonnage
United Kingdom	8,990	9,425,183
Colonies	3,087	1,404,019
Total	12,017	10,829-202
United States	3,573	1,918,175
Norway	3 258	1,456,264
Germany	1,932	1,400,858
France	1,410	984,946
Italy	1,602	846,901
Spain	954	567,781
Sweden	1,460	462,302
Russia	1,217	417,653
Netherlands	539	356,081
Greece	949	291,120
Austria	380	276,294
Denmark	704	259,469
Turkey	875	217,068
Japan	322	174,747
Brazil	501	144,649
Belgium	88	111,934
Other countries	706	246,820
Total	32,662	21,048,704

The average size of vessel owned in the United Kingdom continues to grow in excess of that of all the world, as will be seen from Table II.

TABLE II.

RELATIVE AVERAGE TONNAGES OF ALL THE VESSELS OF THE WORLD AND THE AVERACE TONNAGE OF ALL THE VESSELS OWNED IN THE UNITED KINGDOM DURING FOUR YEARS.

Year	The World	U. K.
1885	607.42	928.64
1886	596.27	907.14
1887	624.65	1004.0
1888	644.4	1055.4

The United States continue second, but, in reality, although Norway occupies the third position, Germany is the third ship-owning nation in the world, if at the present moment it has not surpassed the United States. The greater bulk of the tonnage afloat, owned in the United States and in Norway, consists of sailing vessels: whereas in the case of Germany, more than half the existing tonnage is that of steam vessels. Allowing that a steamer of a specific gross tonnage does three times the work of a sailing vessel of the same net register, the relative efficient tonnage of the three countries in question is as follows:

	Efficient tons.
United States	2,950,677
Germany	2 861.926
Norway	1,827,062

It is thus evident that, despite the enormous seaboard of the United States, and its past success in ship-owning in the days of wood, it is little, if any, greater in importance than Germany. Unless a material change takes place in the policy of the United States Government, we fear there is no doubt what the end will be. Between 1887 and 1888 there was a diminution of 67 vessels and 29,915 tons in our mercantile marine. This is apparently unimportant by itself, but of moment when it is remembered that in the same period Germany showed an increase of 22,203 tons. France, which still holds the fifth position, continues to retrograde, its tonnage having diminished in one year over 1 per cent., as compared with a loss of 6 per cent. in the three previous years. Italy, in 1888, also shows a decline of about ½ per cent. Spain, Sweden, Russia, the Netherlands, Greece, Austria, and Denmark, all occupy the same positions as in 1885, although all but Spain, Greece, and Denmark have retrograded during the last year in the extent of their tonnage. The increases of the three more favored nations are not material. Japan occupies the fifteenth position, and next to the United Kingdom has the greatest increase for the year 1888, viz., 66 vessels and 40,402 tons. These figures speak eloquently for the enterprise of Japan.

Table III. shows the total number and tonnage of all sea-going vessels of and above 100 tons net register, owned by the various countries in the world in the year 1888, and from it we see there was existing at the end of that year 22,402 sailing vessels of 9,496,603 tons. This is 908 vessels and 323,889 tons less than at the end of the previous year. The losses by stranding, collision, etc., and the breaking up of sailing vessels, continues at a higher ratio than the addition of new sailing vessels to the mercantile marines of the world. Out of 1,048 vessels of 563,541 tons removed from the registers of the various mercantile navies, owing to loss, etc., the greater proportion, viz., 853 vessels, of 364,525 tons, were navigated by sails only, and thus one of the chief causes of the diminution in this type of vessel is self-evident.

It is noticeable that, while the whole world's sailing tonnage has declined only 3 per cent., the decline in that of the United Kingdom is relatively greater. The United States has less than the average falling off in sailing tonnage, Norway has a slight increase, Germany has upwards of 6 per cent. reduction, while Italy is even more unfortunate, having over 9 per cent. decrease for the year 1888. Sweden, on the other hand, has a small increase in tonnage, but a decrease in the number of sailing vessels.

TABLE III.

TOTAL NUMBER AND TONNAGE OF ALL SEA-GOING SAILING VESSELS OF AND OVER 100 TONS NET REGISTER FOR ALL COUNTRIES OF THE WORLD IN THE YEAR 1888.

	No. of vessels.	Tonnage.
United Kingdom	3,708	2,535,097
Colonies	2,305	989,290
Total	6,103	3,524,387
United States	3,148	1,401,924
Norway	2,929	1,270,865
Germany	1,292	695,794
Italy	1,461	562,532
Sweden	1,029	298,929
Russia	907	278,247
France	939	244,621
Greece	865	219,241
Netherlands	390	165,528
Turkey	791	153,264
Spain	574	139,048
Austria	255	127,002
Denmark	598	119,373
Brazil	386	81,680
Other countries	554	163,745
Total	22,402	9,496,603

THE CONSTRUCTION OF A LARGE DAM at Milwaukee, Wis., is now well under way, with J. H. KEARNEY as contractor. It is being built across the Milwaukee river by the city, and when completed will enable steamers to run from any point on the river, within the town, to the lake. The contract price is $90,000.

The Fibrous Structure of an Electrical Weld.

In ENGINEERING NEWS of May 5, 1888, and March 23, 1889, a description was given of the process of welding by the electrical current which has been perfected and is now being introduced by the Thomson Electric Welding Co., of Boston, Mass. We have recently seen specimen welds by this process in which the burr at the point of junction had been ground off; and while the line of juncture of the two pieces is plainly perceptible on the outside of the burr, when the piece is reduced to its original size, at this point, the surface of the metal shows not the slightest indications of the point where the two pieces have been united.

We were curious to know, however, whether this line of juncture would become apparent when the polished surface was etched with acid; and at our request the company sent to us the bar from which a print is shown in the accompany engraving. Two pieces of flat wrought-iron of ⅛ in. x 1¾ in. cross section were butt-welded by the electric current, leaving a burr at the weld projecting ⅛ to ¼ in and about ⅛ in. in length measured along the bar. On one of the flat sides this burr was removed by grinding and subsequent planing, and the whole side was polished. The piece was then etched by a strong acid solution. A print was taken directly from this etched piece, and our cut is thus a photographic reproduction of the surface of the iron, the dark spots corresponding to the hollows eaten by the acid, while the white corresponds to the untouched areas of the metal.

The weld is at the center of the bar, and, as seen in the engraving, the metal seems to have been refined and made more homogeneous for about ⅝ in. each way from the point of juncture. Only a few minute hollows are to be seen in the specimen here, while on each side the bar shows the usual coarse fibrous structure of wrought-iron. It seems likely, too, that the metal at this point has been somewhat hardened, since it shows a better polish than the rest of the bar.

The microscopic structure of the metal cannot be shown by our cut; but it is in general well indicated by the coarser structure. The fine fibres seem to run straight across the line of juncture, which, indeed, cannot be discerned, and the metal seems more uniform and homogeneous there than at other points. Indeed, the metal at this point seems in many ways to resemble soft steel.

The success of this remarkable process for welding seems now certain; and its uses and novel modes of application are all the time increasing. One of the latest machines designed is a riveter. Samples of heavy sheets in which the rivets were welded by this process were shown us recently, and were certainly excellent work.

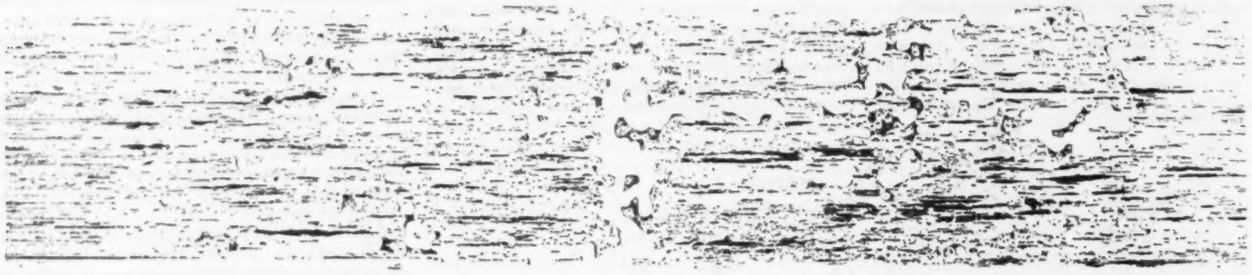
The inventors will do the greatest service to the world, however, if they will perfect a machine to do away with riveting, of longitudinal seams at least, by butt-welding the sheets directly to each other, forming one continuous ring. It is in the butt-welding of large pieces, like shafting, railway rails, boiler plates, and the like, which we are now obliged to join by such means as we can, that electrical welding seems destined to work its greatest wonders, and prove the greatest boon to the race.

A SUIT TO RECOVER FOR DAMAGES BY THE JOHNSTOWN DISASTER has been brought against the Pennsylvania Railroad Co. F. S. TARBELL of Pittsburg whose wife and three children were on the day express which was wrecked at Conemaugh, has sued the railroad company for $50,000 damages.

He alleges that the railroad officials had sufficient notice of the flood to remove the train from its dangerous position, and neglected to do so. The train was held at this point for six hours and was then overwhelmed by the flood.

Wood Vulcanizing.

The company controlling this new process, which is claimed to be more effective than any other for



A Weld by the Thomson Electric Welding Process; Print from a Butt-Welded Bar treated with Acid to show Fibrous Structure.

at once seasoning and preserving timber, has issued a neat little pamphlet, noticed in our issue of Aug. 24, from which we make the following extracts, descriptive of the process, its cost and effect:

To properly preserve and cure wood and lumber, we have only to consider a few simple and self-evident facts. In its growing state, wood is stronger and more elastic than when dry. It contains in its fluids all the antiseptic qualities and elements of self preservation. The tree in the forest, exposed for centuries to atmospheric changes, does not decay; but gird and deplete it of its fluids, and the disintegration of the fibre commences. This, then, is the basic idea upon which the new discovery of "vulcanizing" is founded, and the results obtained accomplish more than is claimed by all previous inventions and discoveries.

In the application of the vulcanizing process, all preconceived methods of curing lumber are reversed, and instead of distilling out these valuable antiseptics, they are distilled *in* the wood itself, a sufficiently high degree of heat under an air pression of several atmospheres being used to allow of their complete affiliation as a new and oleaginous compound. The heat and pressure then being removed, the door is opened, and the tank is emptied and ready for the next charge. Thus it will be observed that, no foreign material being necessary, the process is not only rapid, but so inexpensive as to compel its adoption by all users of wood. When the wood is removed from the cylinder, the new compound now permeating the entire fibre, a chemical change or oxidation takes place while the wood is cooling down, rendering it impervious to moisture, never affected by the changes of the atmosphere or the alternations of wet and dry. Consequently it cannot rot; cannot shrink or swell, offering no point of attack like seasoned or kiln-dried lumber; its pores are filled with its own material, a material composed of the best known antiseptics, and in such shape as to be not soluble in water. Therefore it has been found from thorough and ample tests, during the past six years, that vulcanized wood placed in waters infested by the "teredo" remains as sound as when planted, while companion pieces of the same wood, untreated or natural, have been rendered valueless from the workings of this destructive insect. The "teredo" feeds upon the saccharine matter of the sap and needs the presence of moisture to facilitate its work; in vulcanized wood the character of the whole fluid matter therein is so chemically changed as to offer no inducement to the attack of either the "teredo" or the "red ant."

It is a scientific fact that wood is the source of creosote, pyroligneous acid, tannin, volatile and hydro-carbon oils. "Vulcanizing" develops the above antiseptic properties. "Vulcanizing" demonstrates that it is only necessary to utilize the fluids and juices which nature furnishes to accomplish all that is desired in the way of preserving, hardening, strengthening, and beautifying wood. "Vulcanizing" coagulates the albumen and develops the antiseptics, causes the fluids to diffuse through, and become homogeneous and solid with, the fibre, and causes certain constituent elements contained in all wood to organize into oleaginous compounds, which develop the grain into deep, rich colors, not affected by time or exposure. It prepares the wood to receive a bright and lasting polish, and avoids the necessity of the hitherto great expense of paint and varnish.

Wood vulcanizing, from ample proofs during the last seven years, establishes the fact that it not only prevents the rotting of wood in the most exposed situations, but also prepares green wood of any kind for immediate use in all mechanical work.

To illustrate the great saving accomplished by wood vulcanizing, as against the old methods of air seasoning and kiln-drying, a few comparisons are given below of the woods most in common use, and at average prices prevailing in this city:

	Per M. Ft.
Green Yellow Pine, per M. ft. board measure,....	$25.00
Must be held 2 years—calculate interest at 6%....	3.00
Insurance average, at 3%.....	1.50
Loss by discoloring, warping, checking, etc., 12%	3.00
Kiln-drying taking from 40 to 90 days.....	5.00
Total.....	37.50
Whereas, at a cost of $8.00 per M. ft. board measure, vulcanizing the wood renders it not only perfectly dry, but impervious to atmospheric influences, making it susceptible of the highest finish, equalling mahogany, a result that cannot be accomplished by any of the old methods.	
Therefore, Yellow Pine worth $25.00 per M. ft. and vulcanized at a cost of $8.00 per M. ft.....	33.00
Shows a saving of.....	4.00
Green White Pine per M. ft. board measure,.....	$28.00
The cost of curing this by old methods must be calculated on same basis as Yellow Pine, and would be	13.40
Total.....	41.40
Vulcanized at a cost of $8.00 per M. ft.....	36.00
Showing a saving of.....	5.40
Yellow Poplar and White Wood at about.....	$20.00
This is a very sappy wood, and requires long air seasoning and kiln-drying, losing a large percentage of its first value from discoloration, but for example, is only placed on the basis of Yellow Pine, which is.....	11.00
Total	31.00
As against vulcanizing, which would be,.....	28.00
Shows a saving of.....	3.00
Green Ash.....	$35.00
Cost of preparing by old methods, calculated by same standard as above.....	15.30
Total.....	50.30
This is a large-grain wood of coarse fibre, and by taking away the fluid matter of sap (old methods), makes necessary the use of many "fillers," whereas vulcanizing makes unnecessary such expense—add $8.00 for vulcanizing,..	43.00
Showing a saving of.....	7.30
Green White Oak, at about.....	$40.00
This wood in boards or planks is held from two to five years, according to its thickness. The cost of old methods, calculated as above,.....	17.00
Total.....	57.00
Vulcanized at a cost of $8.00 per M. ft.....	48.00
Showing a saving of.....	9.00

This wood treated by old methods is subject to the same defects and consequent expense of "fillers" as the ash. Vulcanizing not only remedies this, but (as the oak is known as a dye wood), owing to the tannic acid contained in the sap, a color varying from a light brown to a dark, rich shade known as "Antique English Oak," can be obtained. This result obviates the use of all "staining" materials, and multiplies the value many times.

Vulcanized cross ties are supplied at 40 to 80 cts. each, according to locality and are alleged to be good for 30 years. The Manhattan and Suburban elevated Railways are said to be using these ties. The office of the Wood Vulcanizing Co., from which this data is obtained is 40 Wall St., New York. They will doubtless furnish further information on application.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Shepaug, Litchfield & Northern.—A dispatch from Litchfield states that all but $600 of the required subscription of $30,000 has been raised and no difficulty is anticipated in securing the remaining amount. The proposed branch is to run from New Preston, Conn., to Lake Waramaug.

Mount Penn Switchback.—Tracklaying has begun on this gravity road near Reading, Pa., and it is stated that the road will be in operation in two weeks. The road will be 8¼ miles long, and over 6 miles of this distance the cars will be run by gravity.

Philadelphia & Reading.—The Northeast Pennsylvania R. R. directors have guaranteed to extend that road from Hartaville to New Hope, Pa., on condition that the people along the line subscribe $80,000 in aid of the enterprise. It is thought that the money can be easily raised. Surveys of the line were completed some time ago.

Evansville & Terre Haute.—A press dispatch quotes D. J. MACKEY as saying that the proposed extension from Washington to Jasper, Ind., will be completed without delay. He states that the road will be extended from Huntingburg to Washington, and from Rockport, Ind., to Owensboro, Ky., and that trains will soon be running from Owensboro to Chicago. The Washington & Jasper R. R. Co. has been incorporated to build the line.

Western Maryland.—It is announced that the York & Peach Bottom railway, lately absorbed by this company, will be changed to standard gauge as soon as arrangements can be made for that purpose.——The right of way for the extension of the Baltimore & Harrisburg R. R from York, Pa., to Porter's Station, 14 miles, has been secured, and arrangements made for beginning grading soon.

Concord & Montreal.—At a meeting of the stockholders of the Concord R. R. Co. recently held, it was voted to consolidate with the Boston, Concord & Montreal R. R. Co. under the above name. Under the terms of the consolidation the new company is to possess all the property, rights, and franchises of the consolidated corporations and to assume all their liabilities.

Chicago & Indiana.—It is reported that this company has under consideration the building of a branch to Rockville, Ind.

Cincinnati, Wabash & Michigan.—It is announced that the Mackey syndicate has purchased this road, running from Benton Harbor, Mich., to Anderson, Ind., 164 miles. The line will be extended from Anderson to Rushville, Ind., to connect the road with the Evansville & Terre Haute R. R. About $113,000 has been voted in aid of the proposed extension.

Projects and Surveys.

Allentown & Nazareth.—A movement is on foot among the people of Allentown, Pa., looking toward the construction of a railway from that place to Nazareth, where connection would be made with the Portland & Bangor R. R.

Poughkeepsie & Southeastern.—The movement toward building this road, which is projected to run from Poughkeepsie to Hopewell Junction, N. Y., seems to be taking shape.

Cincinnati & New Bedford.—Incorporated in Ohio to build a line of railway from a point on the Ohio & Mississippi railway in Marion township through Lawrence county to Reed Station on the Bedford & Bloomfield branch of the Louisville, New Albany & Chicago R. R, a distance of about 14 miles. Among the incorporators are F. BARNARD, ARTHUR G. WELLS and EDMUND P. CUTTER.

West Branch.—Incorporated in Pennsylvania to build a railway from Coudersport, Potter county, to the west branch of Pine creek near Burrows school house, a distance of 17 miles. Among the directors are: W. B. CUTLEY, of Newfield, Pa., FRANK A. RAYMOND, of Coudersport, Pa., and THOS. COULSTON, of Genesee Forks, Pa.

SOUTHERN.—Existing Roads.

Kentucky Midland.—About 2,000 men are now at work on the line between Paris and Georgetown, Ky., and work is being pushed rapidly to completion.

Atlantic & Danville.—Tracklaying has been completed from Danville, Va., to Milton, and the grading is nearly completed from Milton to Clarksville. About 1,000 men are now at work on the road, and it is expected that the line will be opened for traffic by Oct. 1.

Middle & East Tennessee.—It is stated arrangements have been made whereby the completion of this road to Hartaville, Tenn., is assured.

Decatur, Chesapeake & New Orleans.—About 34 miles of the grading and trestlework have been completed, and 16 miles of track have been laid. The contracts for a second division of 100 miles will be let this fall. S. C. SANDUSKY, of Shelbyville, Tenn., is President.

Alabama Midland.—Jas. M. Brown & Co., of New York, have the contract for building the extension from Montgomery, Ala., northeast to Tuscaloosa, Ala., a distance of 110 miles.

Atlantic Coast Line.—A press dispatch from Rocky Mount, N. C., states that the extension from Williamston to Plymouth, N. C., 24 miles, will be completed and in operation in about 60 days.

Paducah, Tennessee & Alabama.—This road, which is projected to run from Paducah, Ky., to Florence, Ala., a distance of 200 miles, is now under construction between Paducah and Paris, Tenn. It is expected to have the road completed from Paducah to the Tennessee state line by Feb. 1, 1890. A large amount of local aid has been secured from the towns along the route.

West Virginia Central.—JAMES PARSONS, of Davis W. Va., Chief Engineer, sends us the following information

The extension from Thomas to Elkins, W. Va., has been completed, and is now in operation to within ¾ of a mile of Elkins. The work from Thomas to Hendricks was very heavy with a maximum grade of 153 ft. per mile. From Hendricks to Parsons the maximum grade is 26 ft. per mile, and from Parsons to Elkins the gradients are low, with the exception of a short distance, where the maximum grade is 100 ft. per mile. The work of construction was done by the company under the charge of the General Superintendent. Preliminary surveys have been made for an extension from Elkins to Buckhannon, 35 miles, and also from Elkins to the mouth of Williams river in Webster county, W. Va., 72 miles. No locating surveys have been made beyond Elkins.

Seaboard Air Line.—About 1,000 men are now at work on the Georgia, Carolina & Northern R. R. and both grading and surveys are being rapidly pushed.

Charleston, Cincinnati & Chicago.—McDonald, Shea & Co., of Knoxville, Tenn., who have the contract for building this road from Marion, N. C., to Minneapolis, Va., have sublet 50 miles to Wm. Kenebick, of Kansas City, Mo.

Orlando & Winter Park.—The extension of this Florida road to Oviedo is again being agitated.

Louisville, New Orleans & Texas.—The plans for the new roundhouse and machine shops at Vicksburg, Miss., are completed. The roundhouse will contain stalls for 20 engines. There will be a blacksmith and boiler shop 60 x 100 ft., a passenger coach repair shop 60 x 150 ft., and a machine shop 90 x 182 ft. The company will soon call for bids for constructing these buildings.

Chattarol.—The purchase of this road by C. P. HUNTINGTON has given rise to various rumors concerning the building of a railway to open up the rich mineral lands of northeastern Kentucky, southwestern Virginia, and eastern Tennessee. The most practical plan is to continue the Chattarol railway up the Big Sandy river and through the Breaks of Sandy and it is stated that such an extension will be built in the near future.

Talladega & Coosa Valley.—It is announced that bonds have been placed to a sufficient amount to change this road to standard gauge from Pell city to Talladega and to build the extension into Clay county.

Projects and Surveys.

Georgia.—The following bills have been passed by the Georgia Senate: to incorporate the Eatonton & Madison R. R. Co.; to amend the charter of the Chattanooga Southern Ry. Co.; to incorporate the Meion Belt R. R. Co., to amend the charter of the Darien Short Line R. R. Co., and to incorporate the Richmond County Belt Line R. R. Co. Governor GORDON has signed the two latter bills, also a bill to incorporate the Union Railroad & Transfer Co.

Fayetteville & Albemarle.—At a meeting of the incorporators recently held, the following Board of Directors were elected: JOHN BLUE, J. W. MCNEILL, A. A. MCKETHAN, Jr., H. SUTTON, J. M. HAGY, A. B. WILLIAMS, and N. S. BLUE. The directors then elected, JOHN BLUE, President, N. W. RAY, Vice-President, Z. W. WHITEHEAD, Secretary, and A. A. MCKETHAN, Jr., Treasurer. The road as projected will run from Fayetteville, N. C., via Aberdeen to Albemarle, a distance of about 80 miles.

Palatka & Anclote.—The town of Brooksville, Fla., has agreed to raise $20,000 in aid of this road, providing it passes through the corporate limits of that place. W. E. STRONG is Chief Engineer.

Augusta & West Florida.—A railway company under this name has been incorporated in Georgia to build a line of railway from Augusta southwest to Thomasville, Ga., a distance of about 225 miles. Among the incorporators are: A. P. WRIGHT, of Thomasville; C. E. SMITH, of Washington; JAS. M. SMITH, of Oglethorpe; and T. J. DEMPSEY, of Jackson.

Walterboro & Yemassee.—The officers of this North Carolina road, which is projected to run from Walterboro, N. C., to Pregnall's Station are: R. C. BARKLEY, President; A. WICHMAN, Vice-President; and A. S. FARROW, Secretary.

Abbeville & Wayeross.—Incorporated in Georgia by J. D. MAYNARD, A. C. FISHER and others, to build a line of railway from Abbeville to Wayeross, about 80 miles.

Claysville & Short Line.—Chartered in West Virginia to build a railway from Claysville to a connection with the Baltimore & Ohio R. R. near Cameron. JAS. EARDYCE is President.

NORTHWEST.—Existing Roads.

Illinois Central.—The Chicago, Madison & Northern from Lavergne station to Chicago, is nearly completed.

Tabor & Northern.—The following information has been sent us by A. T. WEST, of Tabor, Ia., Secretary:

The surveys have all been completed for this road which is to run from Tabor to Malvern, Ia., a distance of 8.86 miles. The work will be light; maximum grade 2.7 per cent. and maximum curve 7° 30'. The road will do a general freight and passenger business. Canfield, Fleming & Co., of Omaha, Neb., have the contract for building the road. The contract date of completion is Oct. 15. It is expected that tracklaying will begin about Nov. 20, and the road be opened for traffic one month later. The company was incorporated Nov. 1, 1887. The officers are: T. MCCLELLAND, President; WM. M. BROOKS, Vice-President; A. T. WEST, Secretary; J. E. TOOD, Treasurer, and A. S. PROUTY, Auditor.

Illinois Central.—The citizens of Oshkosh, Wis., are trying to induce this company to build an extension from Madison to Oshkosh, Wis.

Yankton, Norfolk & Southwestern.—The town of Aten, Neb., has voted $5,000 of bonds in aid of this road, which is projected to run from Yankton, Dak., to Norfolk, Neb., a distance of 70 miles.

Chicago, Milwaukee & St. Paul.—It is stated that this company has made arrangements for building the line from Chamberlain, Dak., to the Black Hills as soon as the Sioux reservation is opened for settlement.

Winona & Southwestern.—Commissioners have been appointed to appraise damages for the right of way from Bear Creek to Utica, Minn., 10 miles, looking toward the early commencement of construction. D. M. WHEELER, of Winona, Minn., is Chief Engineer.

Manitoba & Northwestern.—Grading has commenced on the extension of this road from Saltcoats northwest. Only a small amount of work will be done this year.

Northern Pacific.—Grading on the extension of the Jamestown Northern R. R., from Minnewaukan to Leeds, Dak., has been completed, and tracklaying is now in progress. It is stated that a considerable distance has been graded beyond Leeds, and that the road will be steadily pushed on to the Turtle mountains.

Northern Pacific & Manitoba.—About 35 miles of track has been laid on the line from Morris to Brandon, Man., 140 miles, and work is now being pushed.——The option which this company had on the purchase of the Great Northwest Central R. R., has been allowed to lapse. It is also stated that the negotiations for the purchase of the Manitoba & Northwestern R. R., are off.

Kansas City, Wyandotte & Northwestern.—Sixteen miles of the grading on the Kansas City & Beatrice R. R. have been completed, and 7 miles of track laid. Tracklaying is now in progress at the rate of 1 mile per day.

Chicago & Northwestern.—A project is on foot to build a branch from the main line to the coal mines at Peru and La Salle, Ill.

SOUTHWEST.—Existing Roads.

Denison Rapid Transit.—F. L. MILLER, of Denison, Tex., Engineer in charge, sends us the following information concerning this enterprise:

The road, which is 6½ miles long, is all within the city limits. The maximum grade is 3.5 per cent. There is one wooden viaduct 1,550 ft. long and 30 ft. wide. The principal business of the road will be in passengers. Col. WM. BRADBURN, of Marshall, Tex., has the contract for building the road. The line has been all graded and tracklaying is now in progress. Filley & Co., of Kansas City, Mo., are the engineers of the road.

St. Louis, Arkansas & Texas.—This road is about to make extensive improvements in its road bed and equipment. Receivers' certificates will be issued at once. The sum of $350,000 will be used in the purchase of steel rails for that portion of the system north of Brinkley, Ark. $189,000 will be set apart for the payment of various claims in Arkansas and Missouri and the sum of $189,000 will be used for a like purpose in Texas. $56,000 will be used in replacing bridges on the Texas lines with new structures.

Red River, Sabine & Western.—The Fort Worth Construction Co., which has the contract for building this road, has sublet the section from Palestine to New Birmingham, Tex., to Burkitt, Murphy & Burns.

Arkansas & Louisiana.—This company proposes to build an extension from Nashville, Ark., west to a point on the Missouri, Arkansas & Texas R. R. in Indian Territory, a distance of about 125 miles.

Projects and Surveys.

St. Louis, Kansas & Southwestern.—Incorporated in Kansas to build a railway from the west bank of the Mississippi river, in the city of St. Louis, in a general westerly direction through Missouri to the east line of Kansas, thence southwesterly through Kansas City to the Indian territory and thence in a general southwesterly or southerly direction through the Indian Territory and Texas to a point on the north bank of the Rio Grande river, together with such branches as may be deemed necessary. The principal offices will be at Kansas City, with branch offices at St. Louis and Guthrie, Ind. Ty. The directors are: T. J. MILLS, Arkansas City; WILLIS KESSLER and H. D. BAKER, Salina; DANIEL HAY and HERMAN HAVIGHORST, Guthrie, Ind. Ty.; T. J. RICHARDSON, Wichita, and T. B. NEEDLES, Muskogee, I. T.

ROCKY MT. AND PACIFIC.—Existing Roads.

North Pacific Coast.—It is stated that the San Francisco, Tamulpais & Bolinas R. R. Co., a notice of whose incorporation was given in our issue of Aug. 31, was chartered in the interest of the above company. The road will start from a point on the main line of the North Pacific Coast R. R. between the stations of Man-

zanita and Blithedale, and run, via Williams, Madrona, and Cascade to Bolinas, Cal.

Puget Sound & Gray's Harbor.—C. S. FREELAND, of Montesano, W. T., Resident Engineer, writes us that the grading on the first 10 mile section of this road is nearly completed. Grading has been completed on the last 10 mile section. Five miles of track have been laid and it is expected that the line will be completed to Montesano by Oct. 1. IRA. C. OTIS is chief engineer.

Port Townsend Southern.—Contracts will soon be let for grading the second 20-mile section of this Washington Territory road.

Northern Pacific.—It is stated that this company will expend about $5,000 in building a new incline, docks and switches at Kalama, W. T.

Projects and Surveys.

Phœnix & Prescott.—A correspondent writes us that at a special election held in Maricopa County, Arizona, on Aug. 27, bonds were voted in aid of a railway to run from Phœnix to Prescott, Ariz., a distance of 140 miles. "Diamond" JOE REYNOLDS is said to be largely interested in the scheme. W. A. MCGINNIS, of Phœnix, is Civil Engineer.

Columbia & Nehalem.—A company has been incorporated in Oregon to build a line of railway from the mouth of Milton creek at Scapoose bay to a point near the mouth of Oak Branch creek. Among the incorporators are: J. C. CARSON, A. KINNEY, C. ROCKWELL, and F. A. MOORE.

RAPID TRANSIT.

Elevated Railway.—*Chicago, Ill.*—The Illinois Elevated Ry. Co. has been incorporated by MICHAEL W. RYAN, JOHN TYLER, EDWARD C. DONNELLAN, WM. W. BELL, and PAUL BROWN, all of Chicago. Capital stock, $10,000,000.

Street Railways.—*New York, N. Y.*—The mayor has vetoed the petition of the Jerome Ave. Ry. Co. to build a street railway on Jerome Ave.

West Troy, N. Y.—A street railway is projected to to Green Island, connecting with the track of the Troy Street Ry. Co.

Blair, Neb.—The Blair Street Ry. Co. has been incorporated by J. T. DAVIES, EDGAR A. STEWART, PERRY SELDON, J. R. CONKLIN, and WM. WALLACE. Capital stock, $100,000.

Olympia, W. T.—The Fourth St. & North Olympia Ry. Co. has ordered rails and ties, and will have a mile of its line in operation by November.

Electric Railways.—*Providence, R. I.*—The Union Ry. Co. has been granted permission to operate its cars by electric storage batteries.

Jamaica, N. Y.—The Jamaica & Brooklyn Ry. Co. will issue $500,000 worth of bonds.

Buffalo, N. Y.—The Citizens Electric Ry. Co. has applied for a franchise for a line on Elk, Franklin and other streets. A public hearing will be given Sept. 19.

Syracuse, N. Y.—The Eastwood Heights Street Ry. Co. has been incorporated to build an electric line from Burnet Ave. to East Syracuse. President, NELSON R. WILLIAMS; Secretary, GEO. B. LEONARD. Capital stock, $30,000.

Pittsburg, Pa.—The Rapid Transit Electric Ry. to Whitehall will build two extensions.

Nashville, Tenn.—A controlling interest in the South Nashville Street Ry. Co. has been purchased by Dr. Wm. MORROW, and a contract has been made with the Short Electric Ry. Co. for the equipment of the line with the Short electric system.

Augusta, Ga.—The street railway company has been granted the right to operate its lines by electricity.

Macon, Ga.—A franchise has been granted for an electric railway 12 miles long, including the present horse car line, which will be a part of the line.

Birmingham, Ala.—The Southern District Telegraph & Electric Co. wants information in regard to the operation of street railway cars by electric storage batteries.

Denver, Col.—The Denver Electric Ry. Construction Co. has been incorporated by JOHN J. RIETHMANN, Jr., J. A. BROWN, CHAS. F. MUSGROVE, FRANK ENANS, and GEO. W. BRIGGS. Capital stock, $300,000. The Thomson-Houston system will be used.

Portland, Ore.—The Multnomah Street Ry. Co. has contracted for the equipment of its Washington & B St. line, with the Sprague electric system. There will be a power house, two 80 H. P. engines, and 10 motor cars.

Oakland, Cal.—An electric railway to Hayward's is projected. Mr. T. Prather, President of the Union National Bank, is interested.

Toronto, Ont.—The Metropolitan Street Ry. Co. has applied for power to adopt electric traction on a part of its system.

Cable Railways. — *Washington, D. C.* — Work has been commenced on the 7th St. cable line by the contractor, Mr. Saxton, of Kansas City.

Minneapolis, Minn.—The Minneapolis Street Ry. Co. has been granted permission to extend its cable line on Cedar Ave.—O. W. Meysenburg & Co., of Chicago, have a contract for a cable railway in Minneapolis, including 4,000 tons of cast-iron yokes.

San Francisco, Cal. — The Omnibus Ry. Co. has opened its Howard St. cable line. G. W. DOUGLAS is Chief Engineer. The company has received a new cable 28,400 ft. long and weighing 72,000 lbs., for its Ellis St. line. It was made by the California Wire Works.

HIGHWAYS.

Huntsville, Ala.—The Commissioners' court of Madison county has let the contract for building the last 3 miles of the Vienna pike to Darnell, Lane & Co., and 5 miles of the Madison pike to J. E. Penney, of Hillsboro.

Ware, Mass.—The following proposals have been received for building about 44 rods of new road, the approximate amount of filling being about 4,000 yds.: Mara & Walsh, $1,350; Francis Goverton, $1,300; E. S. Ruggles, $1,050; E. W. Lawton, $984; W. W. Barnes, $924; F. L. Sturtevant, $875, (awarded contract).

Oregon Roads.—Proposals opened Aug. 10 at Dorman, Ore., for the construction of the Long Creek road, were all rejected for non-compliance with the requirements of the advertisement. New bids were opened Aug. 20: D. G. Hall, J. B. McDill, of Nye, and R. H. Patton, of Alba, secured the Camas creek division at $1,440; G. A. Smith, of Pendleton, secured the Bridge creek and North Fork divisions for $6,560, or $7289 per mile. L. W. LOEHR is Superintendent of the Long Creek road.

CONTRACTING.

Lighthouse Work.—The following proposals for work on the Castle Hill light station, R. I., have been received by Major D. P. HEAP, U. S. Lighthouse Engineer, Tompkinsville, N. Y.: Stone: John Beattie, Leetes Island, Conn., 75 cts. per cu. ft. for 1,200 cu. ft. of cut stone for pier, $1.56 per cu. ft. for 400 cu. ft. of cut stone for tower, $2.50 per ton for 200 tons of ashlar stone, $2,024 total. Thos. W. Casey, Groton, Conn., 78 cts., $1.90, $2, $2,096. F. H. Smith, New York: 78 cts. and $1.04 for pier stone, $1.74 for tower stone, $3 and $3.24 for ashlar, $2,232 and $2,592. Connecticut River Granite Co., New York; $1.10, $2.20, $4.20, $3 040. Metal work: Allentown Rolling Mills, Allentown, Pa., $346.16, Phœnix Iron Co., Trenton, N. J., $387.50; Russell Wheel & Foundry Co., Detroit, Mich., $495; Detrick & Harvey, Baltimore, Md. $615; Robert Deeley & Co., New York, $690.

Brick and Pump.—The following proposals for supplies have been received by the Indian Agent at Fort Yates, Dak.: Brick, J. P. Hoagland, Bismarck, Dak., $26.25 for 20,000 brick, $525; $28 for 8,000, $224; total, $749. Henry F. Douglas, Fort Yates, $24.94, $498; $29, $232; total, $730. M. W. Cowley, Aberdeen, Dak., $567, $260.80, $833.80. The contract was awarded to J. P. Hoagland, as H. F. Douglas bid on a lot of other building material and his bid was for all or none. The only bid for pump and tank was from Fairbanks, Morse & Co., Chicago, $1,600.

Sewer Pipe and Pipe Laying.—*Fresno, Cal.*—The following proposals for vitrified, salt-glazed ironstone sewer pipe have been received by the City Clerk:

N. Clark & Sons, of San Francisco: 24-in. pipe, $1.74 per ft.; 18-in., 95 cts.; 16-in., $1.50; 14-in., $1; 12-in., 90 cts.; 10-in., 40 cts.; 8-in., 30 cts., 6-in., 19½ cts. Gladding, McBean & Co.: 24-in. pipe, $1.68 per ft.; 18-in., 90 cts.; 16-in., $1.40; 14-in., 90 cts.; 12-in., 80 cts.; 10-in., 38 cts.; 8-in., 28 cts.; 6-in., 19 cts. L. G. Wilkerson, of Fresno: 24-in. pipe, $1.69½ per ft.; 18-in., 98 cts., 16-in., $1.75; 12-in., 85 cts.; 10-in., 38 cts.; 8-in., 30 cts.; 6-in., 15 cts.; 6-in. Y's, 30 cts. The contract was awarded to L. G. Wilkerson at $45,006.40. The contract for laying was awarded to C. D. Vincent, of San Francisco, at $46,094; the prices were as follows: laying 24-in. pipe, 88 cts.; 18-in., 90 cts.; 16-in., 90 cts.; 14-in., 65 cts.; 12-in., 70 cts.; 10-in., 60 cts.; 8-in., 35 cts.; 6-in., 28 cts. Concrete, 25 cts. per cu. ft.; lumber, $24 per 1,000 ft.; manholes, $50; inspection-holes, $7; flushing tanks, $75. The work includes 23,400 lin. ft. of 24-in. pipe, 6,050 ft. of 18-in., 980 ft. of 16-in., 800-ft. of 14-in., 2,960 ft. of 12-in., 2,000 ft. of 10-in., 7,500 ft., of 8-in., 34,000 ft. of 6-in., 42 T's, 1,534 Y's, 50 curves, 48 manholes, 34 lampholes and 8 flush tanks.

Sodding.—The Aqueduct Commissioners, New York city, have awarded the contract for 6,000 sq. yds. of sodding on the embankment over the new Croton aqueduct at South Yonkers, N. Y., to Rider & Dougherty, at 30 cts. per sq. yd.

Dredging.—The following proposals for dredging in the basin at Albany have been received by JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y.: E. W. Payn, Albany, 12.00 cts. per cu. yd.; P. J. Brumelkamp, Syracuse, 25 cts. The contract was awarded to E. W. Payn.

Wharf.—The Harbor Commissioners, San Francisco, Cal., have received the following bids for constructing Ferry Slip 1 and Clay St. Wharf: Randall Hunt, $39,000; San Francisco Bridge Co., $28,887; San Francisco Contracting Co., 20,804; American Bridge & Building Co., $37,000; Pacific Bridge Co., $30,000; California Bridge Co., $26,269; Darby Laydon, $29,835; B. McMahon & Sons, $26,250. The contract was awarded to B. McMahon & Sons. Engineer MANSON'S estimate for the work was $27,000.

Market Prices.—*Rails.*—New York and the East, $28 to $28.50 at Eastern mills. Pittsburg, $30 at mill, for delivery in 1889. Chicago, $32 to $32.50 for standard sections, $35 for 30 and 35-lb. sections.

Track Material.—New York: splice bars, 1.85 cts. to 1.90 cts. delivered; spikes, 1.95 cts. to 2 cts. Pittsburg: spikes, 2.10 cts., 30 days, on cars; splice bars, 1.80 cts. to 1.85 cts.; track bolts, 2.75 cts. to 2.85 cts., with square or hexagon nuts. Chicago: steel splice bars, 1.90 cts. to 1.95 cts.; iron splice bars, 1.80 cts. to 1.85 cts.; spikes, 1.95 cts. to 2 cts.; bolts, square nuts, 2.50 cts. to 2.55 cts.; hexagon 2.60 cts. to 2.65 cts.; prices, f. o. b.

Wrought-Iron Pipe.—Pittsburg, discounts on black butt-welded pipe, 50%; on galvanized do., 42½%; on black lap welded, 62½%; on galvanized do., 50%; boiler tubes 1¾-in. and smaller, 52½%; 2-in. and larger, 57½%; casing, 5⅝-in., 60%.

Old Material.—Pittsburg: No. 1 wrought scrap, $20 to $20.50, net ton; wrought turnings, $13.50 to $14; car axles, $24 to $25; cast scrap, $14.50 to $15, gross; cast borings, $11.50 to $12.50; old car wheels, $18 to $18.50.

Cribs.—The following proposals were received Aug. 31, for furnishing materials and labor required for building a stone filled crib for the foundation of a lighthouse in Chicago harbor, Ill.

BIDDERS.	Pine timber, 157,596 ft. B. M. Per M.	Pine plank, 5,244 ft. B. M. Per M.	Pine flooring, 7,900 ft. B. M. Per M.	Screw Bolts, 2,280 lbs. Per lb.	Plate washers, 830 lbs. Per lb.	Drift bolts, 9,740 lbs. Per lb.	Spikes, 325 lbs. lb.	Nails, 150 lbs. Per lb.	Transportation and handling of stone, 725 cords. Per cord	Total.
	$	$	$	cts.	cts.	cts.	cts.	cts.	$	$
Green Dredging Co., Chicago, Ill.	24	24	32	6	5	5	5	5	4.00	7,747.30
Hiero B. Herr & Co., Chicago, Ill.	23	20	30	5	5	4	5	5	2.75	6,526.50
W. T. Casgrain, Chicago, Ill.	24	15	25	5	5	4	4	4	1.95	6,034.12
Geer & Crawford, Saugatuck, Mich.	30	30	20	5½	5½	4¼	4½	3	3.50	8,158.77
The Fitz Simons & Connell Co., Chicago, Ill.	29	29	25	10	10	8	8	8	4.00	8,946.17

PROPOSALS OPEN.

Pier Work.—Removing that part of the pier at the foot at E 28 St., East river, which lies east erly of the established bulkhead-line, except the cribwork below mean low water, and building a new wooden pier, with appurtenances, including a sewer-box, on the site of said pier. THE DOCKS COMMISSIONERS, Pier A, North river, New York City. September 17.

Sewers and Paving.—Sewers; regulating, grading and granite block paving. THE COMMISSIONERS OF PUBLIC PARKS, 49, 51 Chambers St., New York City. September 18.

Sewers.—Sewers of 12 and 15-in. pipe, 18 and 20-in. circular brick and 20 x 30, 24 x 36-in. brick. JOHN A. COLEMAN, Commissioner of Public Works, Providence, R. I. September 18.

Bridge.—Substructure for Cedar Ave. Bridge. A. E. SMYRK, City Commissioner, Baltimore, Md. September 18.

Bulkhead.—Repairing bulkhead between piers 36 and 29, East river. THE DOCKS COMMISSIONERS, Pier A, North river, New York City. September 20.

Grading and Drains.—Filling and grading 1,951 ft. of 30-in. surface drain, 3 catch basins, 1,100 ft. of 12-in. cement pipe. Lieut. A. W. VOODES, U. S. A., Fort Hamilton, N. Y. September 20.

Sewerage.—Complete system. GEO. R. BRINGHURST, City Secretary, Houston, Tex. September 23.

Bridge.—Iron bridge, 31 ft. span. FRANK J. O'FLAHERTY, County Surveyor, Kansas City, Mo. September 25.

Asphalt Paving.—Trinidad asphalt sheet pavement on concrete foundation. W. P. RICE, City Engineer, Cleveland, O. September 26.

Roads.—About 5 miles of macadamizing. FRANK J. O'FLAHERTY, County Surveyor, Kansas City, Mo. September 28.

Jail.—At Columbus, Tex. Architect, E. T. HEINER, Houston. CHARLES RILEY, County Judge, Columbus, Tex. September 30.

Electric Lighting.—Three years' contract. JAMES R. BACH, City Clerk, Ann Arbor, Mich. October 1.

MANUFACTURING AND TECHNICAL.

Car Lighting.—The Pullman Palace Car Co. has shipped 22 sleepers to the Cincinnati, Hamilton & Dayton, all of which are wired for electric lighting. The Electrical Accumulator Co's storage cells are employed

Tiling.—The Paving Brick Co., of Nebraska City, Neb., will put in machinery for the manufacture of tiling, as they claim that better clay cannot be found for that purpose. The machinery for making brick has sufficient capacity to turn out between 80,000 and 90,000 brick per day; 80 per cent. will be hard enough for paving purposes.

The Westinghouse Air Brake Co. held its annual meeting recently at Pittsburg, Pa. The election of officers resulted as follows: President, GEORGE WESTINGHOUSE, Jr.; Vice-President, ROBERT PITCAIRN; directors: GEORGE WESTINGHOUSE, Jr., JOHN CALDWELL, H. H. WESTINGHOUSE, T. W. WELSH, ALEXANDER M. BYERS, ROBERT PITCAIRN and W. W. CARD. The new buildings and other improvements at Wilmerding were discussed and the information furnished that the big plant was rapidly nearing completion. The work on the dwelling houses is also progressing rapidly. It is the intention, when the new plant is ready for occupation, to run both it and the Allegheny works for some time at least.

Filters.—The Louisiana Sugar Refining Co., of New Orleans, La., has ordered another of the large size Hyatt filters. Six years ago this company purchased 5 filters, two years ago 3 more; this last order making in all 9 filters. The Hyatt Co. has also closed contracts with the Quaker City Dye Works Co., Philadelphia, Pa., and John N. Stearns & Co., silk manufacturers, Lynchburg, Va.

Electric Blasting Apparatus.— The Laflin & Rand Powder Co., of New York City, has issued an illustrated pamphlet of its gunpowders for various purposes, and describing its patented electric blasting apparatus. This is constructed on the Wheatstone and Siemen's principle, having a horseshoe magnet of iron, wound with coils of insulated copper wire; between the poles of the magnet revolves a cylindrical armature, carrying in its body other insulated wire coiled longitudinally. The rapid revolution of the armature, by suitable means, generates and sustains in the machine an accumulative current of voltaic electricity of great power, which at the moment of its maximum intensity is, practically, switched off to the outside circuit in which are the fuses, and in the interior of each fuse the ignition is accomplished instantly. The great advantage in the use of such apparatus for blasting is the greater effect produced by the simultaneous firing of a number of blasts.

Artesian Well Plant.—The Pierce Artesian Well Co., of 80 Beaver St., New York, has shipped one of its largest machines, for 3,000 ft. wells, to central Texas. Also two portable drilling rigs to the Northwest Territory, Canada, and another to Montana. A portable prospecting rig has been ordered for the U. S. of Colombia.

Locomotives.—The Rhode Island Locomotive Works, of Providence, R. I., have built a passenger engine for the New York & New England, according to plans prepared by Mr. J. B. HENNEY, Superintendent of Motive Power. It has cylinders 20 by 24 ins., and driving wheels 69 ins. diameter.

The Pittsburg Locomotive Works, of Pittsburg, Pa., have an order for an engine for the Richmond, Nicholasville, Irvine & Beattyville, Ry.

The Schenectady Locomotive Works, of Schenectady, N. Y., have delivered 10 of the 15 engines ordered by the Louisville, New Orleans & Texas. The order included 10 freight, and 5 switching engines.

The Rogers Locomotive Works, of Paterson, N. J., have an order for 6 engines for the Louisville, New Albany & Chicago.

Cars.—The Pullman Palace Car Co. is building freight cars of 60,000 lbs capacity for the Georgia Pacific; these cars have Wagner doors and Janney couplers. The company has orders for 200 Armour refrigerator cars and 200 Wickes refrigerator cars for the Merchants' Dispatch, and 500 box cars for the Pennsylvania Co. Also 10 cars for the Richmond, Nicholasville, Irvine & Beattyville.

The Carlisle Mfg. Co., of Carlisle, Pa., has contracts on hand for 100 cars for export to Cienfuegos, Cuba; 200 coal cars for the Pennsylvania, and a quantity of mining cars for various points.

The Roanoke Machine Works of Roanoke, Va., have an order from the New York, Lake Erie & Western for 300 coal cars, and from the Norfolk & Western for several hundred coal, coke and freight cars.

Condensing System for Pumping Engines.—Mr. JOHN W. HILL, M. E., of Cincinnati, O., has sold a shop right for his improved system of condensation to the Holly Mfg. Co., of Lockport, N. Y.

BRIDGES AND CANALS.

Bridge Notes.—*Quincy, Mass.*—The new Neponset pile bridge is nearly completed. It is 600 ft. long, and 41 ft. wide, having a roadway 33 ft. wide. The piles are of oak, in bents spaced 16 ft. apart; capped by 7 x 14 ins. timbers; the stringers are of hard pine, 7 x 14 ins., spiked to the caps with ¾-in spikes. The roadway is of 4-in. pine plank covered with 2-in. spruce plank. The plans were prepared by Mr. H. T. WHITMAN, C. E., and the contract was let to Benjamin Young at $20,267. The work has been done under the supervision of Mr. JOHN P. PRICHARD, Commissioner of Public Works.

Rochester, N. Y.—The Board of Aldermen has passed a resolution authorizing the mayor to contract with L. L. Buck for the preparation of plans and specifications for the Alexander and Edinburgh street river bridge, for a consideration of $1,000.

Mahwah, N. J.—The following proposals for an iron bridge near Mahwah have been received by Messrs. Campbell & De Baun: Dean & Westbrook, New York, $1,600; Variety Iron Works, $1,604.68; Penn Bridge Co., Beaver Falls, Pa., $1,610; Riverside Bridge Co., $1,645; Wrought Iron Bridge Co., $1,654; Groton Bridge Co., Groton, N. Y., $1,664; Berlin Iron Bridge Co., East Berlin, Conn., $1,692; King Iron Bridge & Mfg. Co., Cleveland, O., $1,750; Pittsburg Bridge Co., $1,760. The contract was awarded to Dean & Westbrook.

Towsontown, Md.—The County Commissioners have awarded to the Iron Bridge Co., of Canton, O., the contracts for wrought iron Pratt truss bridges over the Gunpowder falls, on the Beckleysville road, at $1,738; over Gwynn's falls, at McDonough Station, Western Maryland R. R., at $1,036.35, and over Herring run, at Coxon's Mill, at $1,856.28. The contract for a similar bridge over Herring run, near Taylor's Church, was awarded to the King Iron Bridge & Mfg. Co., of Cleveland, O., at $668.

Washington, D. C.—The project for a bridge over the Eastern branch at the foot of South Capitol St. is still being agitated.

Cincinnati, O.—The third bridge across the Ohio river, leading from Cincinnati to Kentucky, was opened Sept. 4. The first was the suspension bridge to Covington, the second the Newport railway bridge leading to Newport. The third is a part of the new bridge built for the Chesapeake & Ohio railway, and runs from Third and Smith Sts., Cincinnati, to Covington. Its approaches on both sides of the river are high above the river front streets. The length is 4,200 ft.

Nicholasville, Ky.—The Shiffler Bridge Co., of Pittsburg, Pa., has the contract for a bridge 1,600 ft. long for the Richmond, Nicholasville, Irvine & Beattyville Ry., for about $100,000. The road will shortly build a similar structure across the Kentucky river at Irvine, Ky., to cost $100,000, and bids will soon be asked for. A. E. RICHARDS, Louisville, Ky., is President.

Gallatin, Tenn.—The city will build an iron bridge of 80-ft. span across the creek at Water St.

St. Charles, Mo.—The contract for the construction of the Cattleville bridge has been let to the St. Louis Bridge & Iron Co. for $385. The contract for the stone abutments of the bridge at Smith's lake has been awarded to Anton Elbers, at $2,95 per perch.

Waco, Tex.—The County Commissioners have awarded the contract for the county suspension bridge bonds to the Fidelity Trust Co., of Kansas City, the price paid being 4 1-10 cts. premium. The bonds are 80 in number and of $1,000 each. These bonds are to run 20 years at 6 per cent. The money is to be used in paying for the Bruceville bridge, the Bosque bridge and the suspension bridge.

Ossawatomie, Kan.—The Ossawatomie Bridge Co. has been incorporated by J. B. REMINGTON, J. CHESTNUT, GEO. ROBERTS, H. B. SMITH, and A. GORE, of Osfawatomie. Capital stock, $5,000.

Denver, Col.—The Board of Public Works has received bids for the removal of the old Larimer St. bridge. The Wrought Iron Bridge Co., of Canton, O., bid $475; the King Iron Bridge & Mfg. Co., of Cleveland, O., bid $250 conditional upon receiving the award for the construction of the new bridge, which it put in Aug. 20, otherwise the sum of $200 will be added to the original bid. Bids for the removal of the old abutments and construction of new ones were received from Hayes & McGilvray and Geddes & Greene. The bids were made in detail and must be submitted to the city engineer before decided upon.

New York State Canals and Bridges.—The following proposals have been received and contracts awarded by JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y.:

Vertical wall on the Erie canal at Ilion, west of the aqueduct, for which $15,000 was appropriated. The work was given to Sprague & Co., of Syracuse, at $10,439.50. The other bidders were: John H. Nelson, Herkimer, $14,642; G. V. Rapp, Canajoharie, $12,443; Hallinan Bros., Little Falls, informal; McGuvoy, Murray & Co., Elmira, $13,254.25; Flood & Riley, Sandy Hill, $13,793; Troy Public Works, Co., Troy, $12,189; P. J. Brummelkamp, Syracuse, $12,763; C. D. Fenton, Little Falls, $12,232.50; J. Connolly, Elmira, informal.

For building a dam on the Black river, above Forestport pond, for which $45,000 was appropriated; awarded to Philip McGuire, of Forestport, at $44,847.50. The other bidders were: Stryker & Huntington, $68,970; Willard Johnson, Fulton, $57,465; Flood & Riley, $64,855.

For building 800 ft. of pier and breakwater and dredging, for which $21,000 was appropriated; awarded to Harbrecht & Allegewater, of Buffalo, at $18,873. The other bidders were F. N. Potter, $24,529; Belden & Van Wagner, $19,239.50.

For repairing Oswego wall and culvert, appropriation $10,000; let to P. J. Brummelkamp, of Syracuse, at $6,648. The other bidders were Wm. Patrick, $9,922, and Thomas Lane, $6,934.50.

For building an iron bridge at Prospect St., Lockport, appropriation $4,000; the substructure let to James Robinson, Rochester, at $1,253, and the superstructure to the Rochester Bridge & Iron Co., at $2,026. The other bids for the superstructure were: Hilton Bridge Co., $2,200; Shepard & Son, $2,628; Groton Bridge Co., $2,600; King Iron Bridge & Mfg. Co., Cleveland, O., $2,200.

For an iron bridge at Culver St., Rochester, for which $16,000 was appropriated; the substructure was awarded to Weider & McMahon, at $10,030.55, and the superstructure to the Rochester Bridge & Iron Co., at $4,175. The other bidders were: substructure, George Chambers, $10,113.50; B. P. Smith, $10,252.40; William Patrick, $15,428.50. Superstructure, Hilton Bridge Co., $4,790; Shepard & Son, $4,976; Groton Bridge Co., $5,657; King Iron Bridge & Mfg. Co., $4,600.

For changing machinery on Clyde and Brockport bridge, for which $4,150 was appropriated; awarded to Weider & McMahon, Rochester, at $4,004.25.

Canals.— *Champlain.*—The following proposals for improving 3,250 ft. of the Champlain canal have been received by JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y.: Troy Public Works Co., $31,101.75; W. R. Finch, Glens Falls, $37,770; J. W. Whalen & Co., Whitehall, $38,890; Flood & Riley, Sandy Hill, $35,432.90. The contract was awarded to the Troy Public Works Co.

Cornwall.—Davis & Sons, contractors, have completed the repairs and strengthening at lock No. 20.

ELECTRICAL.

Electric Light.—*New York, N. Y.*—The East River Electric Light Co. has increased its capital stock from $500,000 to $1,000,000.

Moorestown, N. J.—The township committee has made a contract with the electric light company for 120 lights of 25 c. p. at $15 per annum.

Bradford, Pa.—The Bradford Electric Light & Power Co. has been granted a franchise. A Thomson-Houston plant will be put in. President, G. N. POTTER; Secretary, F. E. WOOD. Capital stock, $50,000.

Allegheny, Pa.—The contract has been awarded to the Westinghouse Electric Co., for $141,158. The O'Bierne mast-arm has been adopted, and will be placed in portions of the city where the towers are not to be erected. The contract is for a plant including 52 towers with 216 arc lights, 100 mast arms with 1 light each and 2,130 incandescent lights. Fifteen of the towers will be 125 ft. high and 37 will be 150 ft. high. The city will own the plant after trial of 6 months.

Lexington, Va.—An electric light franchise is to be applied for.

Lynchburg, Va.—Proposals for lighting the city with 140 electric lights of 1,500 c. p. will be received by J. D. SULLIVAN, Chairman of the Committee on Lights, until Oct. 1.

Cordele, Ga.—An electric light plant will be put in by J. E. D. SHIPP, or by J. B. FELDER, of Americus.

Waycross, Ga.—A contract for lighting the city has been awarded to M. ALBERTSON.

Savannah, Ga.—The city will make a contract for electric lighting, and the Mutual Gas Light Co. will put in a plant.

Vicksburg, Miss.—The Hill City Electric Light Co. has purchased its plant.——The Louisville, New Albany, & Chicago Ry. Co. will put in a plant at its new shops.

Detroit, Mich.—The Detroit Electric Light & Powez Co. has been organized, and is practically a reorganization of the Fort Wayne Electric Co. It will bid for the city lighting. President, W. B. MORAN; Secretary, WM. H. FITZGERALD. Capital stock, $300,000.

Watertown, Dak.—The contract for arc and incandescent lighting has been awarded to the Thomson Houston Electric Co.

Council Bluffs, Ia.—The Council Bluffs Electric Light & Gas Co. has been incorporated by CHARLES Q. EASTON and W. S. WRIGHT. Capital stock $300,000.

Belleville, Kan.—The Belleville Light & Power Co. has been incorporated by J. M. DOYLE, E. A. HALLOWELL, GEO. W. COLLINS and others. Capitol stock, $50,000.

San Jose, Cal.—An electric light franchise for 30 years has been granted to AUGUST BOWIE. An arc and incandescent plant will be put in.

Campbellford, Ont.—The contract for domestic and street electric lighting has been awarded to the Western Electric Light Supply Co.

SEWERAGE AND MUNICIPAL.

Jackson, Tenn.—Proposals for materials and construction, of a sewerage system for this city are advertised elsewhere this week. Mr. J. D. COOK, of Toledo O., is the engineer. Drawings and specifications will be ready on Sept. 20. Attention is called to the terms o payment.

Street Work.—*Portland, Me.*—The County Commissioners have decided to pave the Cape Elizabeth end of Portland bridge; the solid fill part, and will soon advertise for proposals.

Morganton, N. C.—About $5,000 will be spent in macademizing the streets, and persons of lawful age will be taxed $7.20 or work 12 days per annum on the streets.

Sewers.—*Northampton, Mass.*— The contract for the State St. sewer has been awarded to the Metropolitan Construction Co.

Portchester, N. Y.— The Village Trustees received 13 bids on Aug. 29, but the opening of the same was adjourned until Sept. 12, as the trustees were not positive what right they have to lay the sewer as planned. The outlet sewer, or iron pipe intercepting sewer, runs across the mud flats for 1,400 ft. Jos. R. RIDER, C. E., of South Norwalk, Conn., is the engineer.

Newark, N. J.—In a discussion about a system of sewerage, at a recent meeting of the Sewer Committee, the City Surveyor suggested that he be authorized to prepare a plan for trunk drains, and have the counsel of an eminent engineer. The flume of the intercepting sewer is still undergoing repairs. New breaks are frequently discovered. The surveyor told the committee that it could probably be finished in a month if nothing further were discovered, and the time was extended accordingly.

Louisville, Ky.—The mayor has signed the resolutions for the following sewers: 24-in. brick sewer in Shelby St., from Jefferson to Main, estimated cost, $2,100; 18-in. sewer in Main St., from Brook to Preston, estimated cost, $2,000; 7-ft. circular sewer in Underhill St., Beargrass to Kentucky, to Swan, to Dandridge, to Elliton, to Goss, to McHenry St., estimated cost $50,000.

Rockford, Ill.—The contract for the Cedar St. sewer has been awarded to T. J. Mellon. Owing to a technicality the bid of the Rockford Construction Co. was not considered. The other bids were the following: Duffy Bros. $6,141.80; C. F. McDowell $5,278.85; T. J. Mellon, $4,415.

Milwaukee, Wis. — The contract for constructing a drain along the Blue Mound road has been let to J. C. F. Brand at $1.55 per ft., or about $1,500.

Los Angeles, Cal.—The proposed issue of sewer bonds has been defeated. The vote was 3,851 in favor, and 3,158 in opposition, but 4,673 was necessary to carry the bonds.

Boston, Mass.—The city treasurer has been authorized to issue registered certificates of indebtedness of the city for $500,000, payable July 1, 1919, with interest at the rate of 3½ per cent. this sum to be spent under the direction of the city engineer in enabling the city to extend the improved sewerage system.

WATER-WORKS.

NEW ENGLAND.

Ellsworth, Me.—Six miles of pipe are now being laid under the supervision of EPHRAIM DYER.

Springfield, Mass.—A plan has recently been presented to the Water Committee by Alderman MCFETHERIE favoring the abandonment of the present source of supply and the taking of water from Cooley and Bircham's brooks. The cost of carrying out his scheme and capacity of the projected source he estimates as follows:

Water privilege, with dam, and 75 acres, $60,000; repairs to dam, $15,000; duplicate pumping machinery, water-wheel, etc., $40,000; 24-in. cast-iron main to Bircham's Bend, $50,000; contingencies, $15,000; total, $180,000. A 24-in. water main from Bircham's Bend will deliver about 7,000,000 galls. of water in the same time and under the same pressure that a 24-in. water main will deliver 4,000,000 galls. from the Ludlow reservoir, on account of the friction caused by the water passing through 9 miles of cast-iron pipe. This gain over the Ludlow reservoir would do away with the necessity of laying another new main for some years to come.

Westfield, Mass.—A special meeting was to have been called to see what action is to be taken in regard to issuing new water bonds, and paying those due October 1.

Boston, Mass. — The Alderman have authorized the Water Board to take by purchase or otherwise the necessary lands in the towns of Ashland and Hopkinton for a basin for storing and purifying the water of the Sudbury river and tributaries.

MIDDLE.

Buffalo, N. Y.—The Water Commissioners have been authorized to lay new mains on several streets.

Allegheny, Pa.—The Superintendent has been instructed to prepare specifications for two duplex pumping engines for the Troy hill station, and the Controller has been authorized to advertise for bids for the same. Filters have been proposed.

Canton, N. Y.—We are indebted to C. E. CHAMBERLAIN, Clerk of the Trustees, for the following

Water-works are under construction for the city with Moffett, Hodgkins & Clarke, Watertown, N. Y., as contractors. The supply will be from the De Grasse river, by pumping to a stand-pipe 20 ft. in diameter and 70 ft. high. A 1,000,000-gall. Deane pump will be used. There will be 6 miles of 10 to 4-in. cast-iron mains, and 50 hydrants. Ludlow valves and hydrants will be used. Cost, $39,250. Population, 3,000. E. C. COOK is designing, and J. LELAND FITZGERALD, Schenectady, constructing engineer.

New York, N. Y.—A hearing will be given by the Aqueduct Commissioners, on Sept. 25, on the question of locating and constructing a storage reservoir on the west branch of the Croton river, near Carmel.

Rochester, N. Y.—A resolution has been passed providing for the appointment of a special committee of five members of the council to examine into the merits of the systems proposed by the hydraulic engineers for an additional water supply. The executive board has authorized the publication of 5,000 copies of the reports of the hydraulic engineers on the project for an additional water supply.

West Troy, N. Y.—The Green Island Water-Works Co. is putting in a storage tank 80 ft. in diameter by 30 ft. high, with a capacity of about 700,000 galls. Half of the tank will be below ground, and its bottom will be placed in cement.

Tuxedo Park, N. Y.—Address the Tuxedo Park Association for information regarding works formerly reported as projected at Monroe.

Madison and Chatham, N. J.—We are indebted to C. M. BUSH, Clerk of the Township of Chatham, for the following:

The population of the Madison fire district is about 3,000. A water supply is much needed and a committee of six has been appointed, of which JAS. A. WEBB and JEREMIAH BAKER are members.

Passaic, N. J.—The City Council has agreed to make a 21-years' contract with the Acquackanonk Water Co., which now supplies the city, on condition that the rates to private consumers shall be the same as those charged in Paterson.

Summit, N. J.— The following is from CARROL PH. BASSETT, of Newark:

The Commonwealth Water Co., of Newark, is now building works, which will be known locally as the Summit Water Co.'s works. The pipe has been bought of the Warren Foundry & Machine Co., office at 160 Broadway, New York; the valves and hydrants, of R. D. Wood & Co., Philadelphia. The supply well is being constructed by R. R. COURSON, Newark. CARROL PH. BASSETT is the engineer.

Du Bois, Pa.—Work was begun Aug. 1 by the United States Water Co. The supply will be by gravity, and the works will cost about $30,000. Population, 6,000.

Kutztown, Pa.—The company will begin construction soon. Some of the pipe has arrived.

SOUTH ATLANTIC A SOUTH CENTRAL.

Liberty, Va.—The city has voted $10,000 of bonds for a new reservoir and other improvements.

Morgantown, W. Va.—E. M. GRANT, Engineer for the company, has sent the following:

Works have just been completed at a cost of about $35,000 by the Union Improvement Co. Ludlow hydrants were used, 15 in number. There are 8 miles of 6 and 4-in. cast-iron pipe. Water is taken by gravity from a mountain stream. Population, 3,500.

Sumter, S. C.—Estimates for water-works are being made. Address the Sumter Electric Light Co.

Charleston, S. C.—The reservoir recently built by the Water Co. gave way Sept. 3, the only damage being to the structure itself. It had a capacity of 6,000,000 galls., and its embankments were built upon piles and crib-work, and consisted of red clay and marsh mud, lined on the inside with 2-in. plank, racked back, and dovetailed to make a thickness of 10 ins. It is said that the failure was caused by a leak which washed away a part of the embankment so that the wooden lining could not withstand the pressure of the water. A new reservoir will be built, and until then water will be distributed from the reservoir below the one that failed.

Florence, Ala.—A 120-ft. stand-pipe and two 3,000,000-gall. Worthington pumps will be erected.

Brownsville, Tenn.—Address A. W. BROCKAWAY regarding desired new works.

Nashville, Tenn.—A new 10,000,000-gall., direct acting vertical Worthington pumping engine has just been contracted for. The steam cylinders will be 41 and 82 ins. in diameter, the pump plungers 26½ ins. in diameter, and the stroke will be 60 ins. It will work against a head of 300 ft.

Central City, Ky.—We are indebted to T. C. DU PONT, Engineer of the company, for the following: The Central City Water Co. are putting in works to cost about $40,000. Work will be done by the Central Coal & Iron Co., of Central City. A Deane pump will lift water from Green river to a reservoir 50 ft. square and 15 ft. deep. There will be two miles of 8 to 3-in. cast-iron pipe and 15 hydrants.

NORTH CENTRAL.

Cincinnati, O.— The committee appointed by the Chamber of Commerce to report upon the location of a pump-house in Eden park, has reported against its location upon the site proposed by the Superintendent, and their report has been adopted.

Dowagiac, Mich.—J. O. BECROFT has sent us the following:

Keating & Sheehan, Detroit, are the contractors for works now being built by the city. The pipe and specials will be from Dennis Long & Co., Louisville, Ky. Mathews hydrants and Galvin valves will be used. There will be 8¼ miles of mains and 71 hydrants. Population 3,500.

Connersville, Ind.—The water is thought to be impure, and JOHN N. HURTY has been engaged to analyze it and report to the City Council.

Fort Sheridan (Highland Park P. O.) Ill.—We are indebted to Capt. C. P. MILLER, U. S. A., for the following:

The time for the completion of the contract for pipe and hydrants has been extended to Dec. 1. The water tower, pumping station, and pumping machinery will not be completed before June 1, 1890.

Antigo, Wis.—J. F. DOYLE, Mayor, has sent the following:

The City Council has recommended that works be built on the rental system and has ordered a special election, on Sept. 17, to decide the question. Several propositions have already been made, and if the election is favorable one of these will be accepted.

Terre Haute, Ind.—Estimates for filters are being made.

Monticello, Ind.—A committee from the aldermen has been appointed to decide upon the system of water-works best suited to the town.

NORTHWESTERN.

Helena, Mont.—Negotiations are pending for the consolidation of the lesser companies with the Helena Water Co. A special agent for several California fire insurance companies has examined the fire protection facilities of Helena, and it is said that he declares them far ahead of those of half the Western cities.

SOUTHWESTERN.

Kansas City, Kan.—The Aldermen are discussing the rates charged by the national Water-Works Co. Some claim that they are too high, but Supt. JONES insists that they are not. The rates are based upon an average of those charged in the four cities, St. Louis, Mo., Louisville, Ky., Quincy, Ill., and Memphis, Tenn., and must not exceed this average.

Beaumont, Tex.—An enlargement of the works has been proposed. Address the mayor.

Cleburne, Tex.—Surveys are being made under orders from the City Council. Artesian wells are talked of and bids for sinking the same have been asked.

Houston, Tex.—An 11,000,000-gall. reservoir will be built, and new and larger mains laid. The improvements will cost about $100,000.

Laredo, Tex.—The Improvement Co. has just made a contract with J. W BYRNES, of Galveston, to bore an artesian well, 2,000 ft. deep if necessary.

South Denver, Col.—At a recent citizens' meeting it was resolved that the supply of water from the Denver Water Co. is inadequate, and a committee was appointed to call upon the company and to insist upon an increased supply.

PACIFIC.

Olympia, Wash. — The Olympia Water Co. have offered to double the capacity of the supply main, to increase the daily pumping capacity to 2,000,000 galls., to construct a 1,000,000-gall. reservoir, and to set 20 new 3-in. hydrants, on condition that the city agrees to pay a hydrant rental of $120 each per year for 25 years.

Fossil, Ore.—The Fossil Water Co. has been incorporated with a capital stock of $3,000. F. B. HOONER, S. B. LAMB and P. PATTERSON are among the incorporators.

Oceanside, Cal.—The city has voted $15,000 of 7 per cent. bonds with which to purchase and enlarge the works now owned by the Oceanside Water Co. The bonds have been placed and construction will be started at once.

San Diego, Cal. — The San Diego Flume Co. have proposed to the Water Committee of the Council to pipe the city and rent the pipes to the city at 6 per cent. of their cost, and supply any quantity of water up to 3,000,000 galls., at 10 cts. per thousand for the first 1,500,000 galls., 9 cts. for next 500,000 galls., 8 cts. for next 500,000 and 7 cts. for next 500,000, an average of 8¼ cts. per thousand, provided the whole 3,000,000 galls. are used. For all over 3,000,000 the price to be 6 cts. per thousand gallons.

CANADA.

Windsor, Ont. — A new pump has been successfully tested.

Regina, N. W. Ty.—A 50,000-gall. tank, to be placed on a 50-ft. tower, will be erected for fire protection at the Government barracks. The contract has been awarded to Mr. STEWART, of Ottawa, Ont.

ARTESIAN WELLS.

Red Wing, Minn.—It is believed that a good flow has been secured at the well at the Reform school. The well is down 575 ft.

Bismarck, Dak.—An artesian well company has been incorporated.

Whitewood, Dak. — An attempt will be made to secure a government appropriation for the sinking of a well.

Santa Fé, N. M.—The Santa Fé Artesian Well Co. propose to put down a test well with the idea of eventually developing a supply of artesian water.

IRRIGATION.

Kansas. — Since 1885 five large canals have been constructed in the western part of the State. They take water from the Arkansas river, have a length of 336 miles, and irrigate 300,000 acres. Artesian wells have been used for local irrigation, especially in Meade, Morton, and Graham counties. The extent to which artesian wells can be used for irrigating purposes is now being investigated by order of the State Board of Agriculture.

Colorado.—About 700 men are at work on the Bessemer canal, which is now open for about 12 miles. By Oct. 1, it will have been completed from the head of Madon's Station to a point opposite Pueblo.